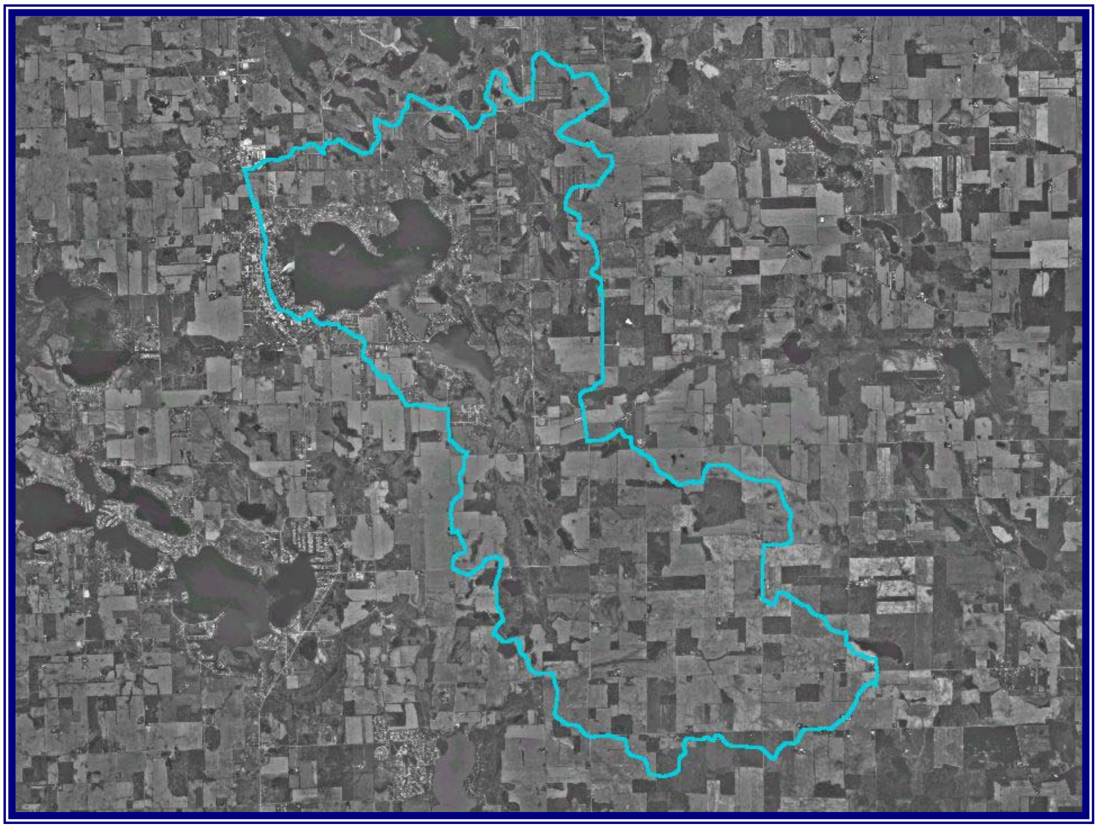
Webster Lake Engineering Feasibility Study

KOSCIUSKO AND WHITLEY COUNTIES, INDIANA

May 18, 2004



Prepared for:

Webster Lake Conservation Association
c/o Dawn Meyer
606 North Albert Eckert Drive
North Webster, Indiana 46555

Prepared by:

JFNew

708 Roosevelt Road
Walkerton, Indiana 46574
574-586-3400

EXECUTIVE SUMMARY

The Webster Lake Conservation Association (WLCA) received an Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) grant to complete an engineering feasibility study on lake improvement projects identified during the Webster Lake Diagnostic Study in 1999. The goal of the feasibility study was to analyze potential future project sites where sources of pollution may exist, suggest projects that may address the pollution, and examine the feasibility of design and constructing a project on the site. To be deemed feasible, a project must be acceptable to property owners, receive regulatory agency support, be physically constructible, and be environmentally and socially justifiable.

The study pursued the feasibility of three projects within the Webster Lake watershed: sedimentation basin construction on a 30-acre parcel north of Epworth Forest Road, wetland restoration in the Gaff Ditch headwaters, and streambank erosion control installation at the County Road 750 West bridge over Gaff Ditch. The study also continued the work or the 2001 North Webster Storm Drain Engineering Feasibility Study through the identification and mapping of storm drains around Webster Lake and the Backwaters. Of these three feasibility projects, wetland restoration in the Gaff Ditch headwaters was determined to be infeasible at this time. The cost estimate for the sedimentation basin construction was approximately $30,000 with design-build funding to be pursued from the IDNR LARE program in 2004. The streambank erosion control project is estimated to cost no more than $2,000. The Whitley County Highway Department and a private contractor can complete the project in 2004.

It is recommended that the Webster Lake Conservation Association complete work on both the sedimentation basin construction project and the streambank erosion control project.

ACKNOWLEDGEMENTS

This feasibility study was performed with funding from the Indiana Department of Natural Resources Division of Soil Conversation and the Webster Lake Conservation Association. Dawn Meyer of the Webster Lake Conservation Association and Lynn Stevens of the Tippecanoe Environmental Lake and Watershed Foundation provided initiative and assistance in getting this study completed. Special thanks are due to property owners Bart Culver and Gene Klingaman for their assistance. Authors of this report include Sara Peel, Joe Exl, and John Richardson with JFNew.

TABLE OF CONTENTS

PAGE

TABLE OF FIGURES

PAGE

TABLE OF TABLES

PAGE

TABLE OF APPENDICES

WEBSTER LAKE ENGINEERING FEASIBLITY STUDY
KOSCIUSKO AND WHITLEY COUNTIES, INDIANA

1.0 INTRODUCTION

1.1 BACKGROUND

The Webster Lake Conservation Association (WLCA) has recognized that lake water quality is directly connected to activities in the watershed. Webster Lake is a eutrophic lake that is susceptible to nuisance duckweed population growth, algae blooms, and re-invasion by Eurasian water milfoil. In 1999, the WLCA received a grant from the Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) Program to conduct a lake and watershed diagnostic study in order to document existing conditions in Webster Lake and the Backwaters and to diagnose potential pollutant sources to the lake. According to the Webster Lake/Backwaters Area Diagnostic Study, 85% of phosphorus loading to the lake comes from the watershed (JFNew, 2000). The study suggests that the phosphorus load to Webster Lake would need to be reduced by about 32% to achieve an in-lake phosphorus concentration that would slow eutrophication. The study recommends addressing watershed-level issues before attempting in-lake treatment. In 2001, the WLCA received a grant to determine the feasibility of retrofitting storm drains within the Town of North Webster with pollution control devices. In 2002, the WLCA received a grant to continue working on watershed-level recommendations from the diagnostic study. The purpose of the current study is to determine design and construction feasibility for three recommended projects in the Webster Lake watershed. The study also continues the work of the 2002 WLCA feasibility study by mapping stormwater drains under Kosciusko County jurisdiction around Webster Lake and the Backwaters. The study includes general recommendations for reducing pollution at or upstream of these drains.

1.2 SCOPE OF STUDY

The geographic scope of the study included Webster Lake and the Backwaters and their 31,459 acre (12,736 ha) watershed in Kosciusko, Noble, and Whitley Counties. This feasibility study specifically targeted the headwaters of Gaff Ditch and a small inlet stream off Epworth Forest Road for project implementation. The mapping focused on streets and residential areas immediately adjacent to Webster Lake and the Backwaters under Kosciusko County jurisdiction. JFNew conducted field surveys in the Gaff Ditch headwaters in order to identify locations where water quality improvement projects could be implemented. Storm water drains along roadways in residential areas adjacent to Webster Lake were also surveyed and mapped for inclusion in the county's Geographic Information System (GIS). The feasibility study included several lake/watershed driving tours, visual inspection and mapping of project sites, and several public and private meetings with landowners and stakeholders. The following projects (refer to Figure 1) are included in this engineering feasibility study:

1. Sedimentation basin construction, Culver property, Epworth Forest Road
2. Wetland restoration, Gaff Ditch headwaters
3. Streambank erosion control installation, Gaff Ditch headwaters
4. Storm drain survey, immediate vicinity of Webster Lake and the Backwaters

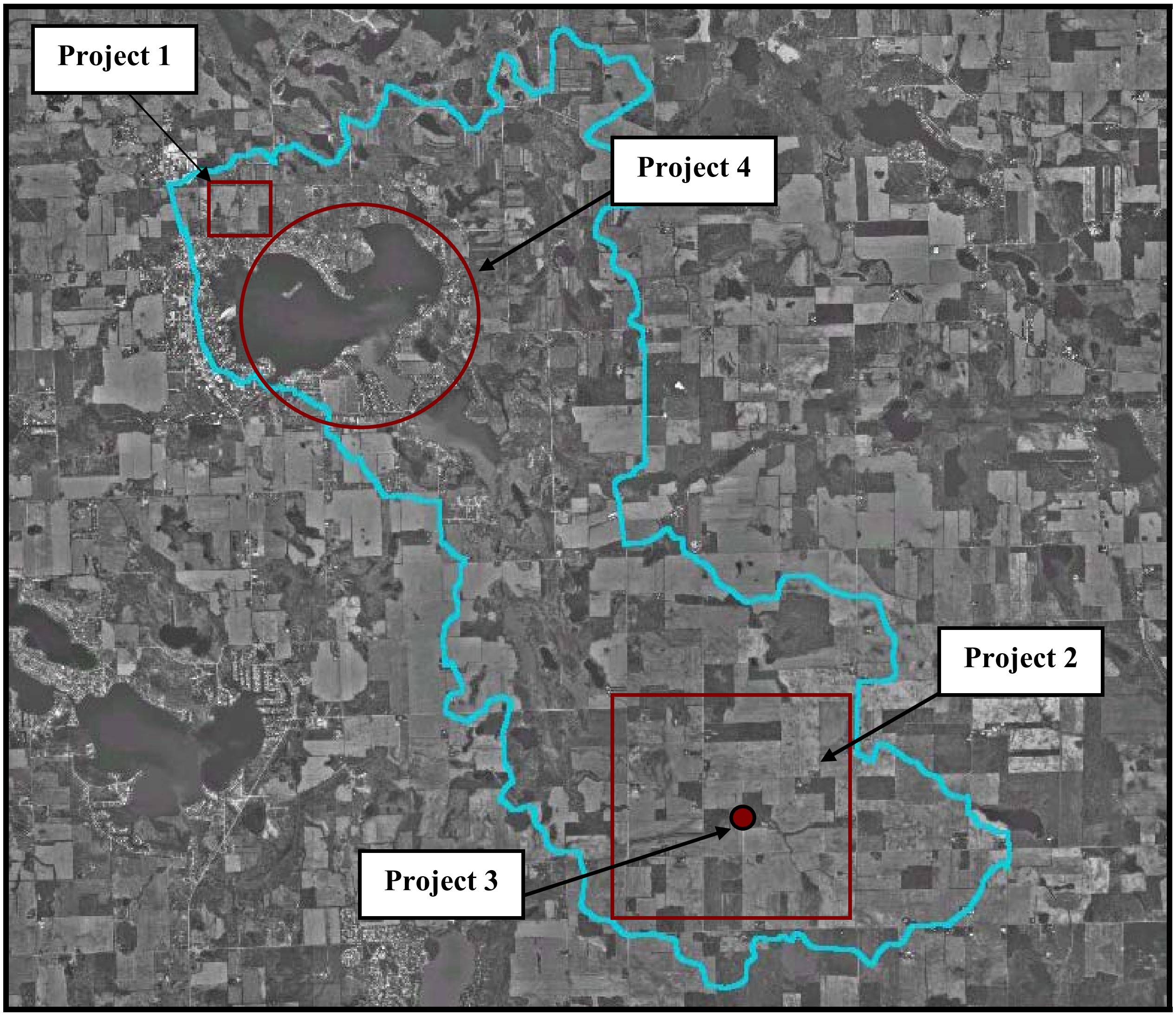


Figure 1. Feasibility study proposed project locations.

1.3 GOALS AND OBJECTIVES

The goal of this study is to identify feasible projects that could be designed and implemented within a reasonable time frame. A project is deemed feasible if it can be constructed, is acceptable to affected landowners, is economically justifiable, and will likely receive regulatory approval. The feasibility study attempted to ensure project success by investigating all avenues that could potentially cause project failure.

2.0 DESCRIPTION OF STUDY AREA

2.1 LOCATION

The Webster Lake watershed (14-digit hydrologic unit codes 05120106010-010, -020, -030, and -040) encompasses 31,459 acres (12,736 ha) in Kosciusko, Noble, and Whitley Counties, Indiana (Figure 2). The watershed includes the headwaters of the Upper Tippecanoe River, which conducts water to the Wabash River, a tributary of the Ohio River. Four main drainages transport water from the watershed to Webster Lake (Figure 3). The main inlet is the Tippecanoe River which drains most of the watershed (Figure 3). Gaff Ditch conducts water from the southwestern portion of the watershed. Two smaller, open channel inlets on the north-northwest side of the lake near Center Street West and Albert Eckert Drive also conduct water to the lake from agricultural and residential areas. The North Webster Storm Drain Engineering Feasibility Study (JFNew, 2002) identified 18 drainage networks which conduct water from the urbanized area of the watershed located at its western edge. Water drains from Webster Lake through the Tippecanoe River to Lake James then into Lake Tippecanoe. Water from Lake Tippecanoe is conducted into the Tippecanoe River which flows southwest through Warsaw before combining with the Wabash River northwest of Lafayette.

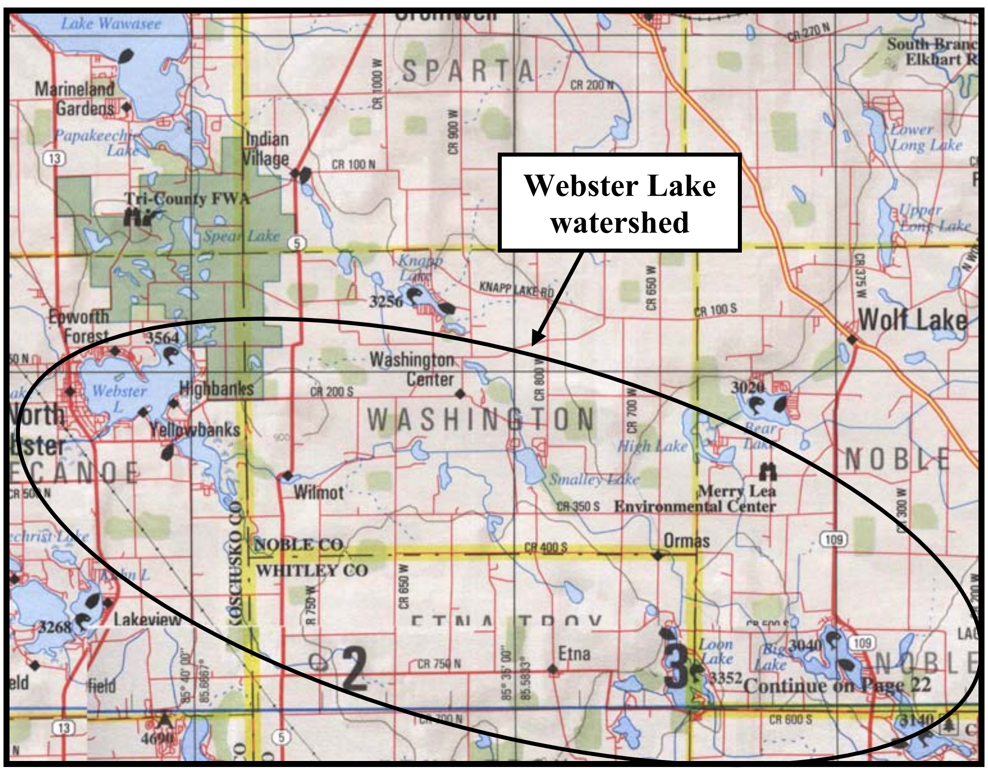


Figure 2. General location.

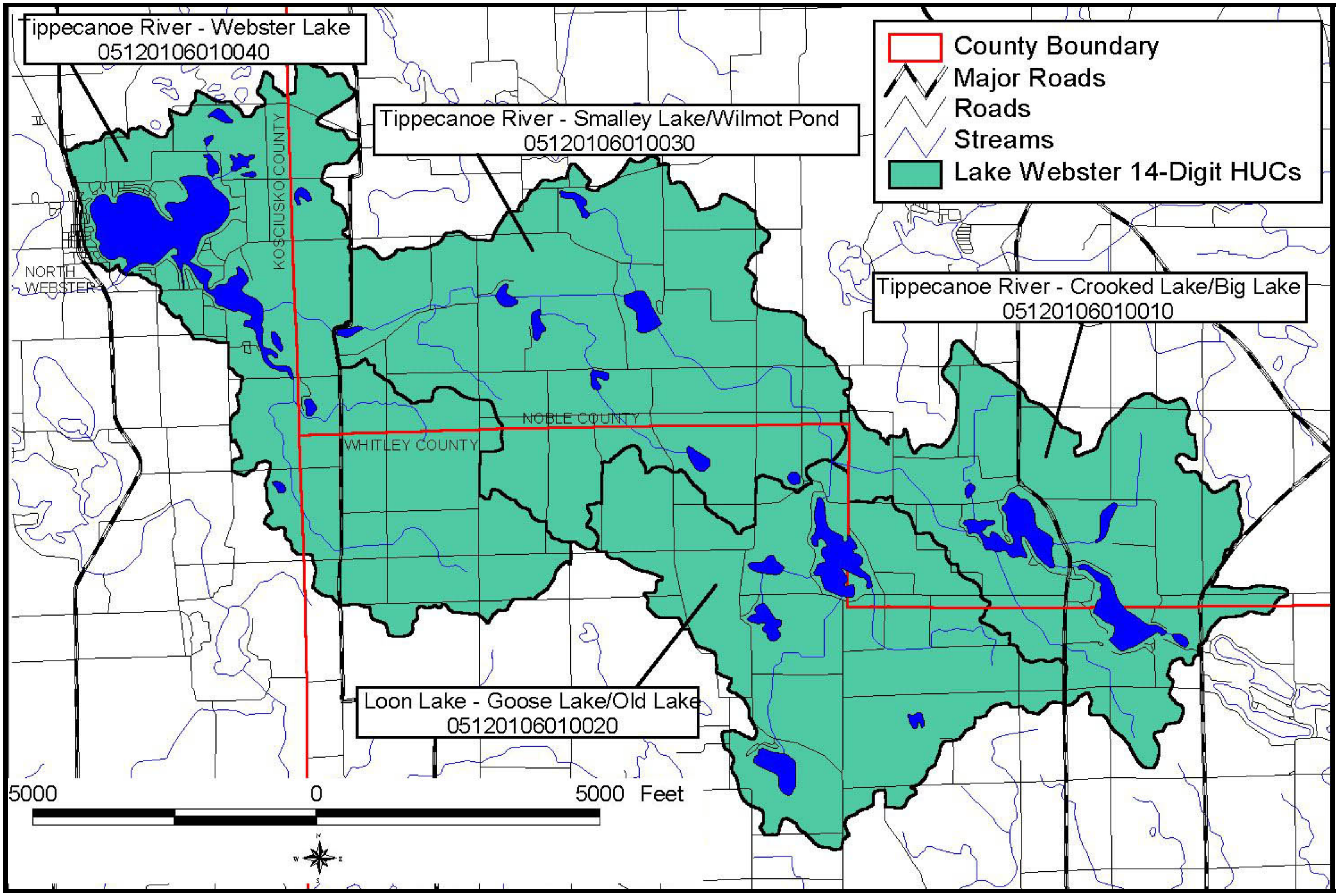


Figure 3. Webster Lake watershed.

2.2 GEOLOGIC HISTORY AND TOPOGRAPHY

Webster Lake formed during the most recent glacial retreat of the Pleistocene era. The advance and retreat of the Saginaw Lobe of a later Wisconsinian Age glacier as well as the deposits left by the lobe shaped much of the landscape in northeastern Indiana (Homoya et al., 1985). The Saginaw Lobe retreat left a broad, flat to rolling glaciated plain which has been classified as the Northern Indiana Till Plain Ecoregion (Omernik and Gallant, 1988). Glacial till and outwash, sandy gravelly beach ridges, flat belts of morainal hills, and bog kettle depressions characterize this ecoregion (Simon, 1997). The topography of the Webster Lake watershed is typical of much of Kosciusko County and was determined to a large extent by glaciation. Topography is gently rolling in the area. Relief ranges from approximately 950 feet above mean sea level at the highest point in the watershed to approximately 853 feet at Webster Lake. The Town of North Webster is located 20 feet above the lake at a relatively steep slope. In fact, State Road 13 which passes through downtown forms the western watershed boundary as storm water on the west side of the road is passed to the Tippecanoe River downstream of Webster Lake and storm water on the east side flows directly into Webster Lake. This results in significant storm water runoff inputs to the lake from impervious surfaces and urbanized areas, which were addressed in the 2002 North Webster Storm Drain Engineering Feasibility Study. It is important to note here that Webster Lake itself is a product of altered hydrology. The lake was formed in the mid to late 1800s when a dam was constructed on the Tippecanoe River, flooding five small, natural lake basins to form the 585-acre (237-ha) impoundment.

2.3 SOILS

The soil types found in the Webster Lake watershed are a product of the original parent materials deposited by the glaciers that traversed the area 12,000 to 15,000 years ago. Soils that directly border Webster Lake to the north and west are of the Wawasee-Crosier-Miami association; these soils are moderately steep, somewhat poorly drained soils. The Ormas-Kosciusko association which borders Webster Lake to the south is dominated by moderately sloping soils that are well drained. The Riddles-Ormas-Kosciusko association encompasses the Town of North Webster and borders Webster Lake to the east. The poorly drained, mucky soils of the Houghton-Palms association form the shoreline of the Backwaters and a small length of Webster Lake's northeastern shoreline. Approximately 30% of Kosciusko County and 60% of Whitley County are mapped as highly erodible soils (JFNew, 2000). It is likely that projects undertaken within the Webster Lake watershed will take place within a variety of soil types and conditions.

2.4 LAND USE

The Webster Lake watershed lies within the Northern Lake Natural Area (Homoya et al., 1985). Natural communities found in this region prior to European settlement included bogs, fens, marshes, prairies, sedge meadows, swamps, seep springs, lakes, and deciduous forests. Like much of the landscape in Kosciusko County, a large portion of the Webster Lake watershed was converted to agricultural land uses. Today, about 76% of the watershed is utilized for agricultural purposes including row crop and pasture (Figure 4). Corn and soybeans are the major crops grown on this land. An additional land use change involves residential and commercial development of the lake's northwestern and western shorelines which currently compose about 2% of the lake's immediate watershed. (For the purposes of this report, the immediate watershed is considered the 14-digit hydrologic unit code (05120106010040) containing Gaff Ditch and the area immediately surrounding the lake.) Wetlands and open water account for approximately

12% of Webster Lake's watershed. Table 1 provides land use acreages for the Webster Lake watershed based on the USGS/EROS Indiana Land Cover Data Set, Version 98-12.

Table 1. Land use in the Webster Lake watershed.

Land Use	Area (acres)	Area (hectares)	Percent of Watershed
Row crop	19,931	8,069	63.4%
Pasture/hay	3,838	1,554	12.2%
Deciduous forest	3,658	1,481	11.6%
Open water	2,124	860	6.8%
Woody wetlands	986	399	3.1%
Emergent herbaceous wetland	532	215	1.7%
Low intensity residential	263	106	0.8%
Evergreen forest	69	28	0.2%
High intensity commercial	27	11	0.1%
High intensity residential	24	9.7	0.1%
Mixed forest	6	2.4	<0.1%
TOTAL	**31,458**	**12,736**	**100.0%**

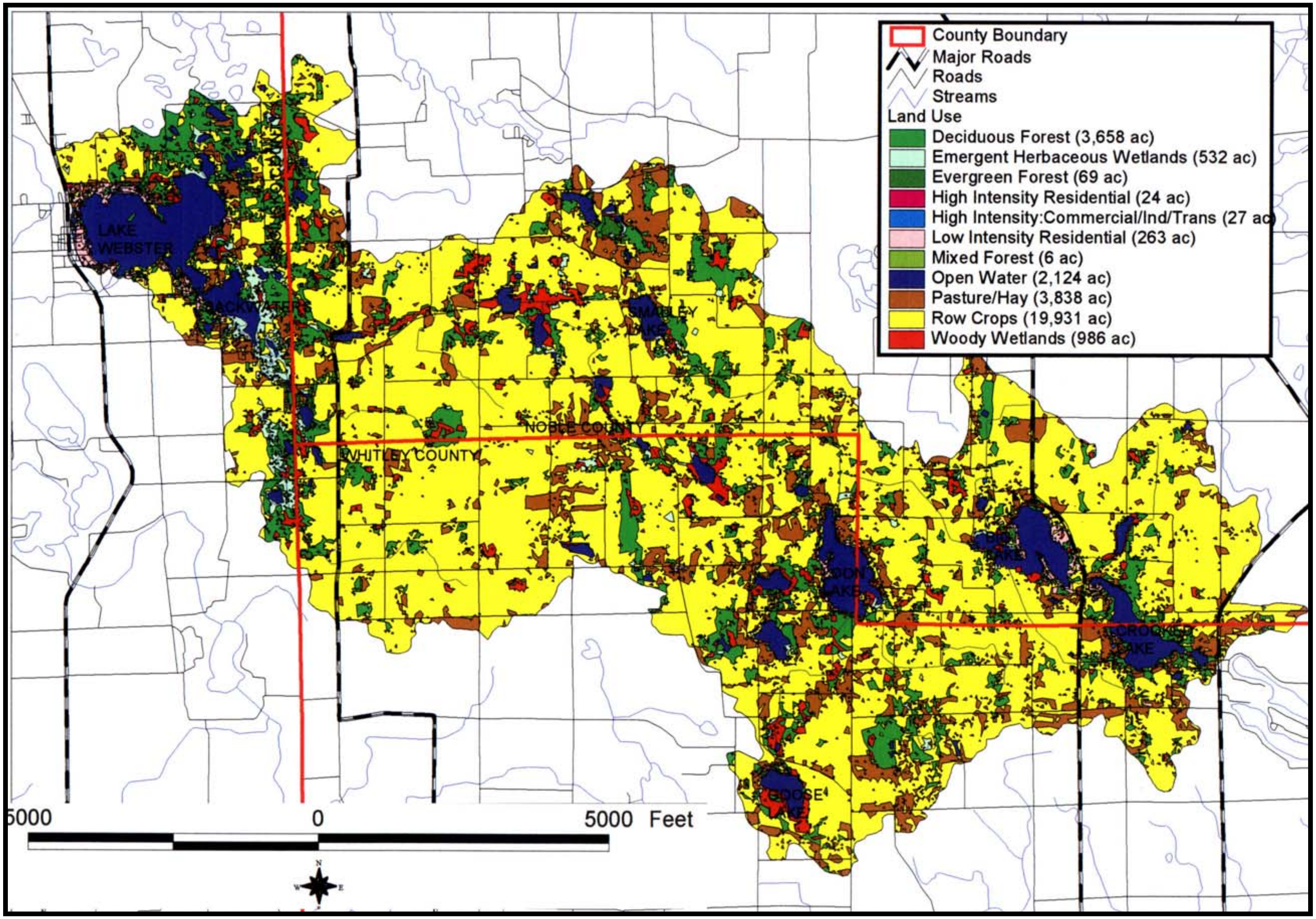


Figure 4. Land use in the Webster Lake watershed.

2.5 EXISTING AND PLANNED BMPs

Existing Best Management Practices (BMPs) in the Webster Lake watershed include agricultural practices like the Natural Resources Conservation Service (NRCS) storm water basin and grassed waterway project recently constructed in the lake's immediate watershed on the northwestern side. The IDNR and the Tippecanoe Environmental Lake and Watershed Foundation (TELWF) also recently worked with the landowner at County Roads 1050 West and 275 East to fence cattle away from the Tippecanoe River. Plans for additional projects are numerous and include those listed in the Upper Tippecanoe River Watershed Management Plan (WMP) for three of the four Webster Lake subwatersheds. With a completed WMP, §319 money is expected to be available for project implementation. The WMP identifies potential project sites in three of the four Webster Lake subwatersheds including the Tippecanoe River-Webster Lake, the Loon Lake-Goose Lake/Old Lake, and the Tippecanoe River-Crooked Lake/Big Lake Subwatersheds. Additionally, in 2003 TELWF received an IDNR LARE grant to complete a diagnostic study in the Tippecanoe River-Smalley Lake/Wilmot Pond Subwatershed to identify BMPs that may be possible in that area. The WMP also includes BMP recommendations developed during an IDNR preliminary assessment of Loon and Goose Lakes in 1992 and of Big Lake in 1995. In the Tippecanoe River-Crooked Lake/Big Lake Subwatershed, the Crooked Lake Association recently completed several water quality improvement projects with funding from §319 and LARE. The Crooked Lake Association installed detention basins, intercepted tile drains, and stabilized eroding stream banks of bioengineering to prevent bank erosion. The Town of North Webster is developing an implementation plan for recommendations made during the 2002 Storm Drain Feasibility Study. TELWF received §319 funding to hire a watershed coordinator for the Upper Tippecanoe River Watershed. This individual will focus on completing the watershed management plan and beginning implementation of potential projects identified within the plan. The BMPs proposed during this current study address five (two potential wetland restoration projects are listed for the Gaff Ditch headwaters) of the identified action items for the Tippecanoe River-Webster Lake Subwatershed listed in the WMP (TELWF, 2002).

2.6 PRIOR STUDIES

Table 2 documents prior studies conducted in Webster Lake and its watershed. Many of the historical studies focused on documenting and managing Webster Lake fisheries and in-lake water quality. More recently studies have focused on watershed management with the recognition that activities in the catchment of the lake affect water quality in the lake. The 2000 diagnostic study was the first to address watershed management of the areas draining directly into Webster Lake. The purpose of the diagnostic study was to: 1) describe conditions and trends in the lakes and their watershed; 2) identify potential problems; and 3) make prioritized recommendations addressing these problems.

Table 2. Current and prior studies conducted in the Webster Lake watershed.

Year	Entity	Topic	Study
1973	USEPA	Water Quality	National Eutrophication Survey Report on Webster Lake
1976	IDNR, DFW	Fisheries	Webster Lake Fish Management Report*
1985	IDNR, DFW	Fisheries	Webster Lake Fish Management Report
1987	IDNR, DFW	Fisheries	Webster Lake Creel Survey

Year	Entity	Topic	Study
1987	ILNHS; IDNR	Mussels	Survey of Mussels in the Lower Wabash and Tippecanoe Rivers
1989	IDNR, DFW	Fisheries	Webster Lake Fish Population Survey
1989	KLPDC; IDNR, DSC	Water Quality	Preliminary Investigation of the Lakes of Kosciusko County
1990	IDNR, DFW	Fisheries	Webster Lake Creel Survey
1990	PCES	Watershed Management	Water Quality Plan for the Upper Tippecanoe River Watershed
1991	IDEM, CLP	Water Quality	Indiana Clean Lakes Assessment
1991	IDNR, DFW	Fisheries	Abundance, Angler Utilization, and Impacts of Muskellunge at Webster Lake
1992	IDNR; F.X. Browne	Watershed Management	Feasibility Studies of Loon Lake and Goose Lake
1993	IDNR; USFWS	Mussels	Mussel Habitat Stability and Impact Analysis of the Tippecanoe River
1993	IDNR, DSC; T. Crisman	Watershed Management	Assessment of Watershed-Lake Interactions Influencing Cultural Eutrophication of Crooked Lake
1994	IDEM, CLP	Water Quality	Indiana Clean Lakes Assessment
1995	USACOE	Water Quality/ Quantity	Upper Tippecanoe River Basin, Kosciusko County Interim Reconnaissance Report
1995	IDNR, DFW	Fisheries	Webster Lake Fish Management Report
1995	IDNR, DSC	Water Quality	Preliminary Assessment of Big Lake
1995	IDEM, IVMP	Water Quality	Seasonal Secchi Disk Monitoring of Webster Lake
1997 to current	IDEM, IVMP	Water Quality	Seasonal Secchi Disk Monitoring of Webster Lake
1998	IDEM, CLP	Water Quality	Indiana Clean Lake Assessment
1998	IDNR, DFW	Fisheries	Webster Lake Creel Survey
1998	IDNR, DFW	Mussels	Natural Lakes Mussel Survey
1999	IDNR, DFW	Fisheries	Muskellunge Population Characteristics at Webster Lake
2000	IDNR, DSC; JFNew	Watershed Management	Webster Lake/Backwaters Area Diagnostic Study
2001	IDEM, OWM	Watershed Management	Tippecanoe River Watershed Restoration Action Strategy
2001	TNC	Watershed Management	Tippecanoe River Project Strategic Plan
2002	TELWF; JFNew	Watershed Management	Upper Tippecanoe River Watershed Management Plan
2002	IDNR, DSC; SePro/Aquatic Control	Aquatic Plant Management	Aquatic Plant Management Study and Plan
2002	IDNR, DSC; JFNew	Watershed Management	North Webster Storm Drain Engineering Feasibility Study

Year	Entity	Topic	Study
2003	IDEM, CLP	Water Quality	Indiana Clean Lakes Assessment
2003 to present	IDNR, DSC; JFNew	Watershed Management	Webster Lake Engineering Feasibility Study

IDEM, OWM = Indiana Department of Environmental Management, Office of Water Management
IDEM, CLP = Indiana Department of Environmental Management, Clean Lakes Program
IDNR, DFW = Indiana Department of Natural Resources, Division of Fish and Wildlife
IDNR, DSC = Indiana Department of Natural Resources, Division of Soil Conservation
ILNHS = Illinois Natural History Survey
IDEM, IVMP = Indiana Volunteer Monitoring Program
JFNew = J.F. New & Associates, Inc.
KLPDC = Kosciusko Lake Preservation and Development Council
PCES = Purdue Cooperative Extension Service
TNC = The Nature Conservancy
USACOE = United States Army Corps of Engineers
USEPA = United States Environmental Protection Agency
USFWS = United States Fish and Wildlife Service
* It is assumed that the IDNR DFW has surveyed other lakes in the Webster Lake watershed, but these studies are not included in the above list.

Many of the studies listed in Table 2 include recommendations to improve specific aspects (fisheries, water chemistry, rooted plant population) of Webster Lake and the Backwaters. This current study explores the feasibility of implementing three of the primary recommendations made in the 2000 Webster Lake/Backwaters Area Diagnostic Study: construct a filter or wetland on a critical property to the northwest of the lake; designate a person to work with the Whitley County Highway Department to stabilize bridge abutments in a critical area; and investigate the potential of restoring two small wetland filters in the Gaff Ditch headwaters. The 2001 North Webster Storm Drain Engineering Feasibility Study addressed the feasibility of implementing a third recommendation of the 2000 Webster Lake/Backwaters Area Diagnostic Study: retrofit 11 city-regulated storm drains with pollutant removal devices and develop an inspection and maintenance plan for these devices. The storm drain survey portion of this feasibility continues its work, expanding it to the area around Webster Lake and the Backwaters under Kosciusko County jurisdiction.

3.0 <u>PROJECT REVIEW</u>

3.1 STORM WATER VOLUME AND VELOCITY REDUCTION PROJECT, CULVER PROPERTY

3.1.1 Site Description and Alternatives

The project area is located on the north side of Webster Lake (Figure 1). It is bounded by Epworth Forest Road to the south, Hoss Hill Road to the east, and Panorama Drive to the west (Figure 5). The project area encompasses approximately 31 acres of predominantly row crop agricultural land with two small, forested tracts in the northeast and southwest corners and a small wetland in the south central portion of the property. A natural swale connects the forested tract in the northeast corner to the wetland in the south central portion of the property. (Appendix A contains photographs of the project site.) Generally, the swale only contains flowing water following heavy rain events. A drainage tile extends from the wetland in the south central portion of the property along the edge of the existing forest. Historically, this tile was connected to an open channel off Webster Lake. The drainage tile was apparently broken during road repair and sewer installation work in the early 1990s. This caused water to back up and restore hydrology to the south central wetland. Water also forms a small pond on the north side of Epworth Forest Road as a result of the road repair and sewer installation work. Ponded water discharges to a 12" diameter culvert underneath Epworth Forest Road and flows overland to an open ditch leading to a channel off Webster Lake.

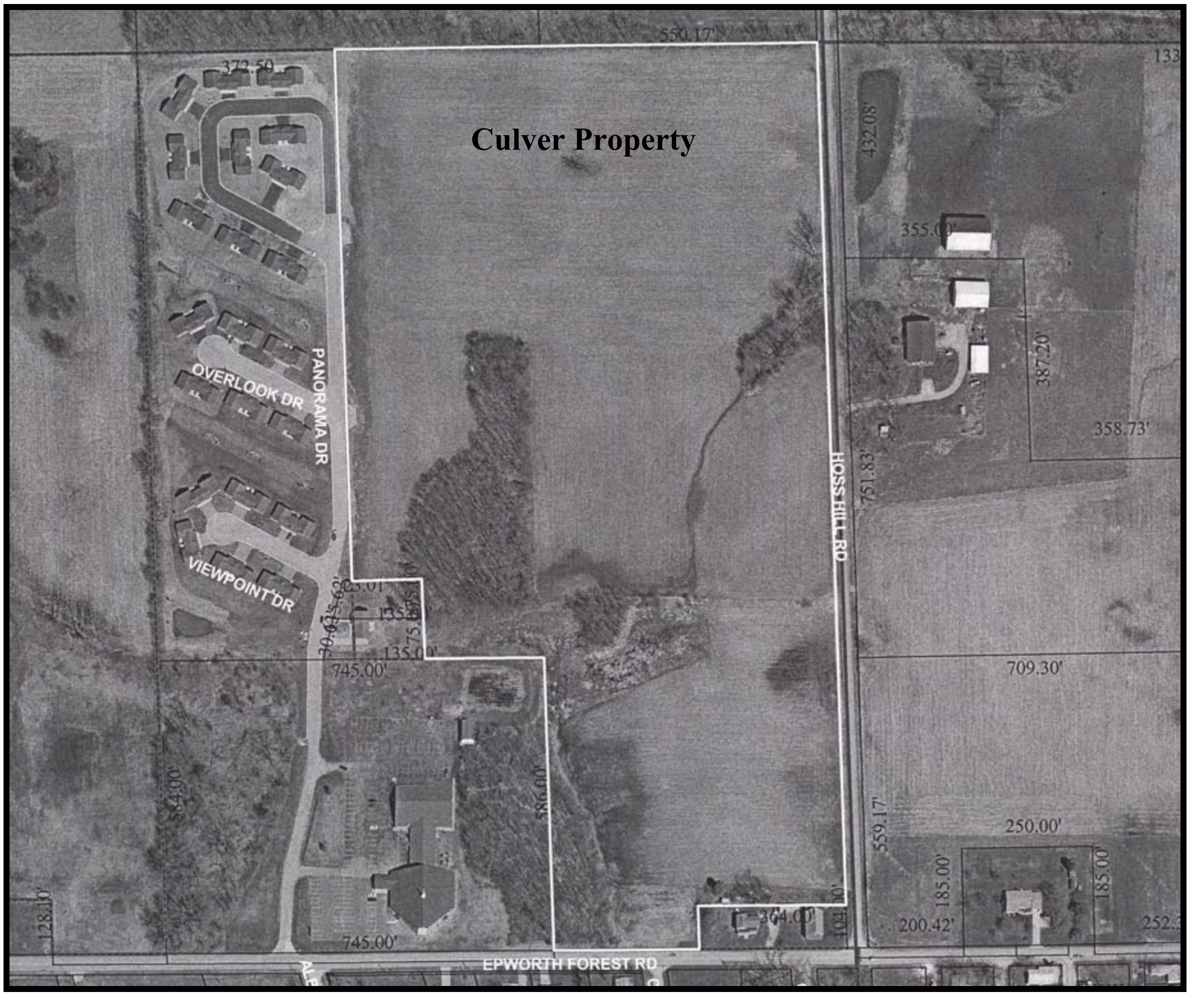


Figure 5. Culver Property project site.

During heavy rain events, water moves quickly from the agricultural fields into the drainage tile and passes under Epworth Forest Road where it collects in residential areas prior to entering Webster Lake. Sediment and sediment-attached pollutants flow from the highly erodible agricultural field and are carried off site with the stormwater. The project area is currently farmed in row crop agriculture using conventional tillage methods. The current site characteristics lead to sediment and sediment-attached pollutant loading to Webster Lake and flooding of residential properties.

Ideas considered for reducing storm runoff and sediment delivery to Webster Lake from the property included converting the entire agricultural production area to prairie, installing a grassed waterway, converting from row crop production to hay farming, restoring the wetland, utilizing no-till farming, creating a detention basin, and combining any of these options. Due to current contractual obligations for farming and potential future development plans, a small sedimentation basin was chosen to reduce stormwater runoff and sediment and sediment-attached pollutant loading to Webster Lake.

3.1.2 Preliminary Design and Conceptual Drawings

A sedimentation basin approximately 0.4 acres in size surrounded by a 25-foot wide prairie buffer is proposed in the southwest corner of the property (Figure 6). The basin will serve as a sediment and sediment-attached pollutant collection basin and will store stormwater runoff from the approximately 30-acre watershed. The sedimentation basin will collect water from both overland flow and subsurface tile flow. The basin will receive subsurface discharge from the existing drainage tile on the parcel. The final design should designate a permanent pool elevation equal to the invert of the existing drainage tile and a bottom depth eight feet below permanent pool level. A water level control structure installed at the downstream end of the sedimentation basin will increase retention time during high flow events, allowing more time for suspended sediments and sediment-attached pollutants to drop out. Water will exit the sediment basin through a pipe to be connected to an existing pipe under Epworth Forest Road. The existing pipe discharges to an unnamed stream that flows into a channel on Webster Lake. The prairie buffer will provide wildlife habitat; reduce sheet, rill, and gully erosion around the basin; and filter pollutants from surface water prior entering the basin. The project could potentially be expanded to replace the drainage tile that connects an area where water currently ponds to the residential area on the south side of the Epworth Forest Road that could alleviate the residents' flooding concerns. The project could also be expanded to replace the open unnamed stream on the south side of Epworth Forest Road with a pipe or tile. This could eliminate a majority of debris and waste that is currently placed in the open ditch from entering Webster Lake.

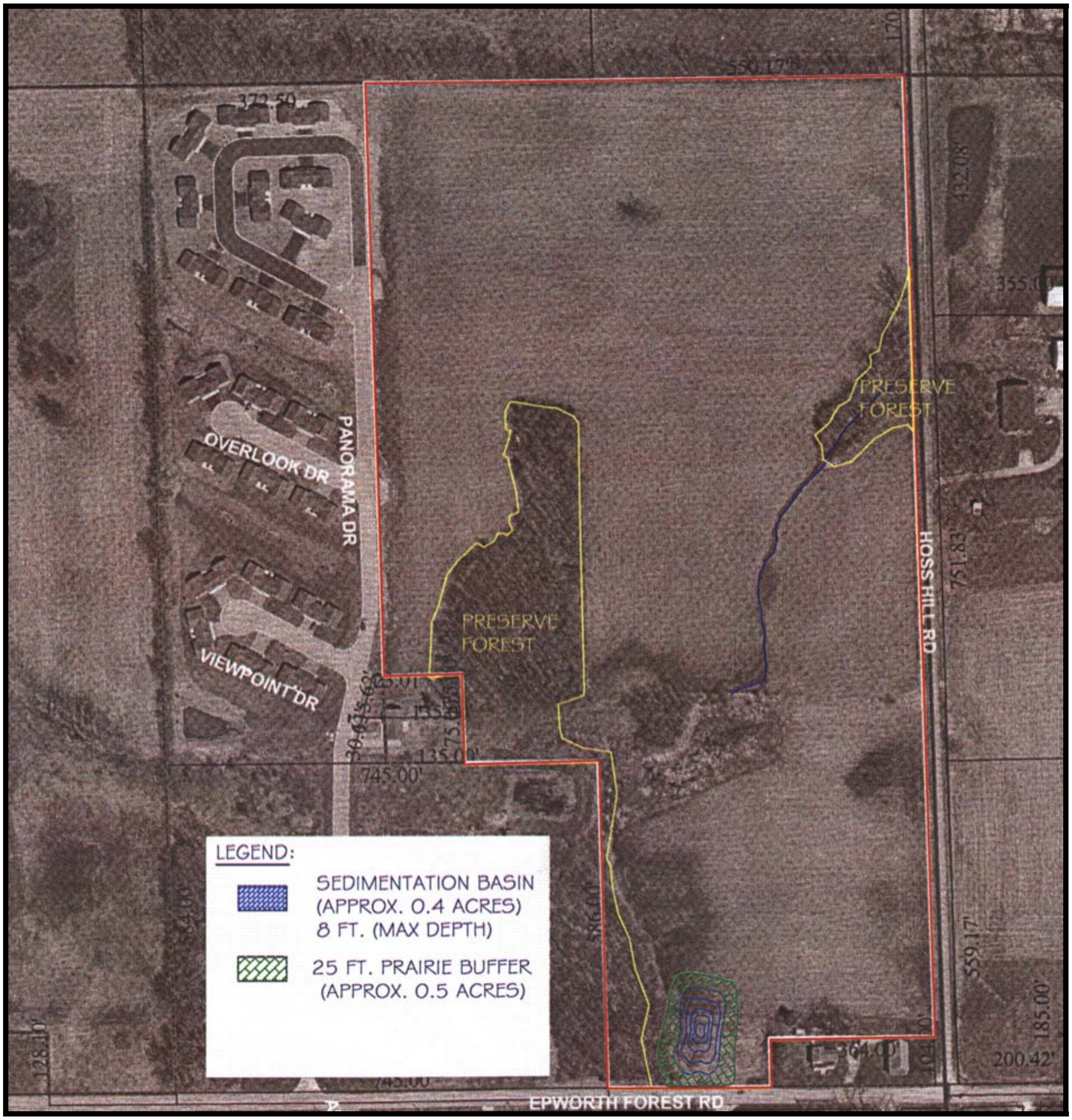


Figure 6. Sedimentation basin plan view.

3.1.3 Permit Requirements

An Indiana Department of Natural Resources permit is not required for the proposed project. The proposed project does not occur in the floodway or State waterway nor will excavation of the detention basin occur below the normal lake water level of Webster Lake. A Section 401 Water Quality Certification from the Indiana Department of Environmental Management (IDEM) and Section 404 Permit from the U.S. Army Corps of Engineers (Corps) are not required for the proposed project because the project does not occur in a "waters of the United States".

3.1.4 Landowner Agreements

A single landowner, Bart Culver, owns the entire proposed project area. Mr. Culver has agreed to the preliminary design of the project. A copy of the agreement is included in Appendix B.

3.1.5 Wetland Functional Assessment

The general location and extent of a wetland located on the project property was mapped during a field survey on November 18, 2003. Figure 7 shows the approximate location of the wetland. The wetland is partially drained and was formerly farmed. It is likely that the wetland has grown in size due the lack of tile maintenance. The wetland functions to filter surface water runoff and provides wildlife habitat, but it likely offers little water storage capacity or groundwater recharge. The plant community is dominated by sandbar willow (*Salix exigua*), cattail (*Typha* sp.), reed canary grass (*Phalaris arundinacea*), willow herb (*Epilobium* sp.), tall goldenrod (*Solidago altissima*), smartweed (*Polygonum* sp.) and small white aster (*Aster vimineus*). The proposed project will not impact the functionality of this wetland.

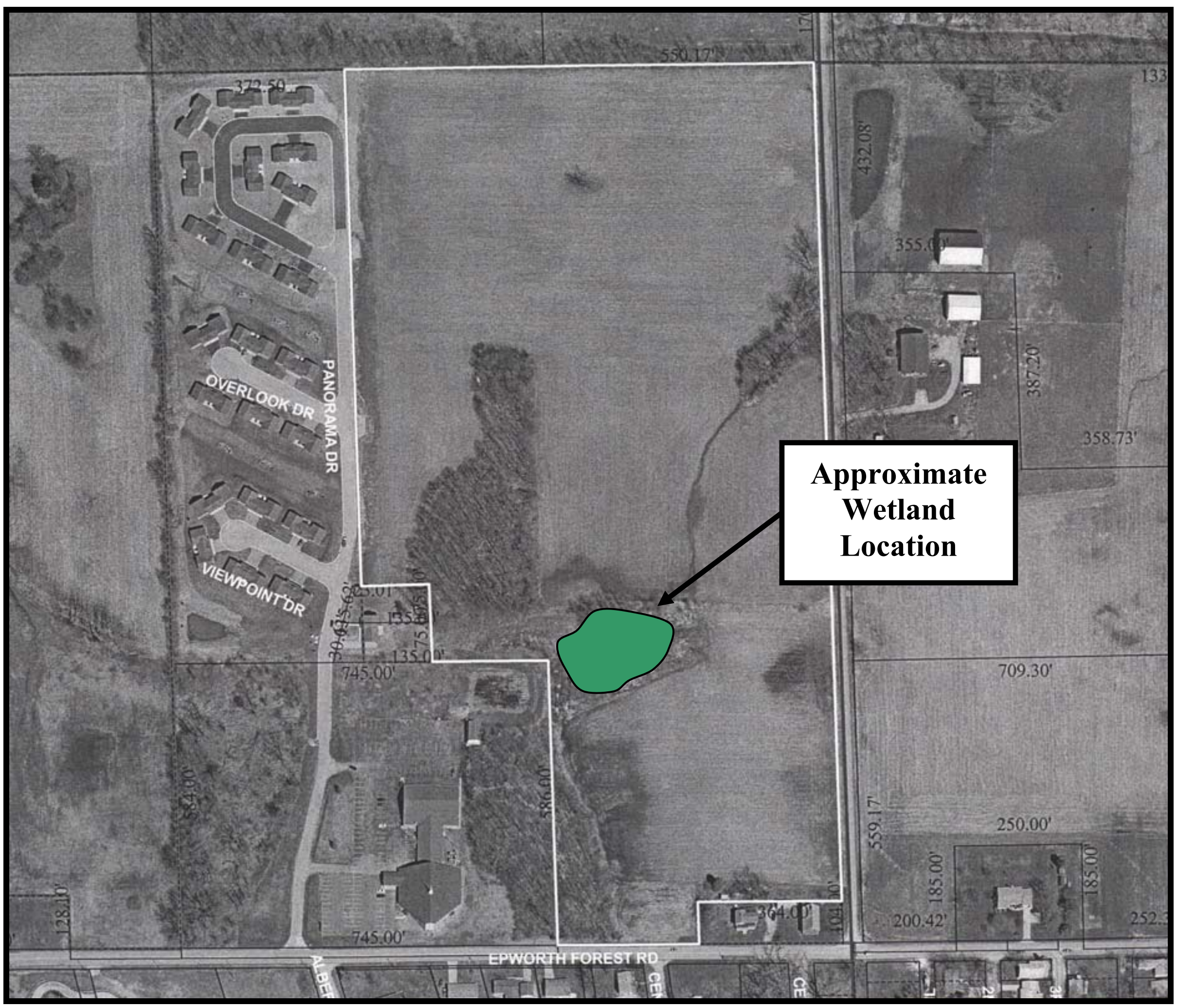


Figure 7. Approximately wetland boundaries on the project site.

3.1.6 Biological and Habitat Integrity Survey

Since no streams or permanent water bodies exist onsite. Biological and habitat integrity surveys were not conducted.

3.1.7 Environmental Impact Assessment

Environmental considerations relevant to the proposed project include: wetlands, endangered, threatened, and rare (ETR) species, water quality, flooding, stream habitat, and stream biota. Sedimentation basin construction on the Culver property can proceed with no impacts to the wetland onsite. The proposed sedimentation basin is located approximately 400 feet south of the existing wetland. Although an endangered species survey was not conducted, the IDNR Division of Nature Preserves (DNP) database does not contain documentation of any ETR species onsite. Since it will not be placed in the existing wetland, it is assumed that this area will continue to function as it has historically. The proposed detention basin will reduce flooding both north and south of Epworth Forest Road by storing water on the property during rain events. The proposed basin should lead to improved water quality in the downstream channel and in Webster Lake as stormwater runoff is reduced. Sediment and sediment-attached pollutant loading rates will also be slowed. During construction, excavation and localized disturbance of the project area may temporarily impair water quality downstream. Water quality impacts are expected to be minimal.

3.1.8 Unusual Physical and Social Costs

Unusual physical and social costs associated with design and construction of the proposed project include: loss of a small area for future residential housing development and loss of a small area for crop production.

3.1.9 Opinions of Probable Cost

The opinion of probable cost for the construction of the detention basin is $30,810 (Table 3).

Table 3. Opinion of probable cost for detention basin construction on the Culver property.

Item	Cost	Unit	Number	Total
Sedimentation basin excavation	$4.00	cubic yard	3,800	$15,200
Blanketing/erosion control	$2.50	square yard	800	$2,000
Seeding	$3,000	acre	1.5	$4,500
Mobilization/demobilization	$2,000	each	1	$2,000
Construction Subtotal				**$23,700**
Final design plans	15%	each	1	$3,555
Construction observation	15%	each	1	$3,555
Subtotal				**$7,110**
Total				**$30,810**

3.1.10 Project Justification and Estimation of Impact

The loss of native upland vegetation and loss of wetland area for agricultural production have resulted in increased stormwater runoff, sedimentation, and nutrient loading to Webster Lake from the proposed project site. Cultural processes, such as artificial drainage, exacerbate the problem by increasing the amplitude of discharge events. Streams in cultivated and pastured watersheds typically possess heavy sediment deposits and variable flows. Although the waterway found on-site is ephemeral, during heavy rain events it delivers stormwater runoff and sediment to Webster Lake. It is likely that sedimentation basin construction will increase on-site storage capacity, improve downstream water quality, and reduce the velocity of water leaving the project site.

3.2 WETLAND RESTORATION, GAFF DITCH HEADWATERS

3.2.1 Site Description and Alternatives

The proposed Gaff Ditch wetland restoration project area is located on the east side of State Road 5 from County Road 700 North to just north of County Road 850 North (Figure 1). The project area encompasses predominantly row crop agricultural land. Forested and pasture land tracts are also scattered throughout the three square mile area (Figure 8).

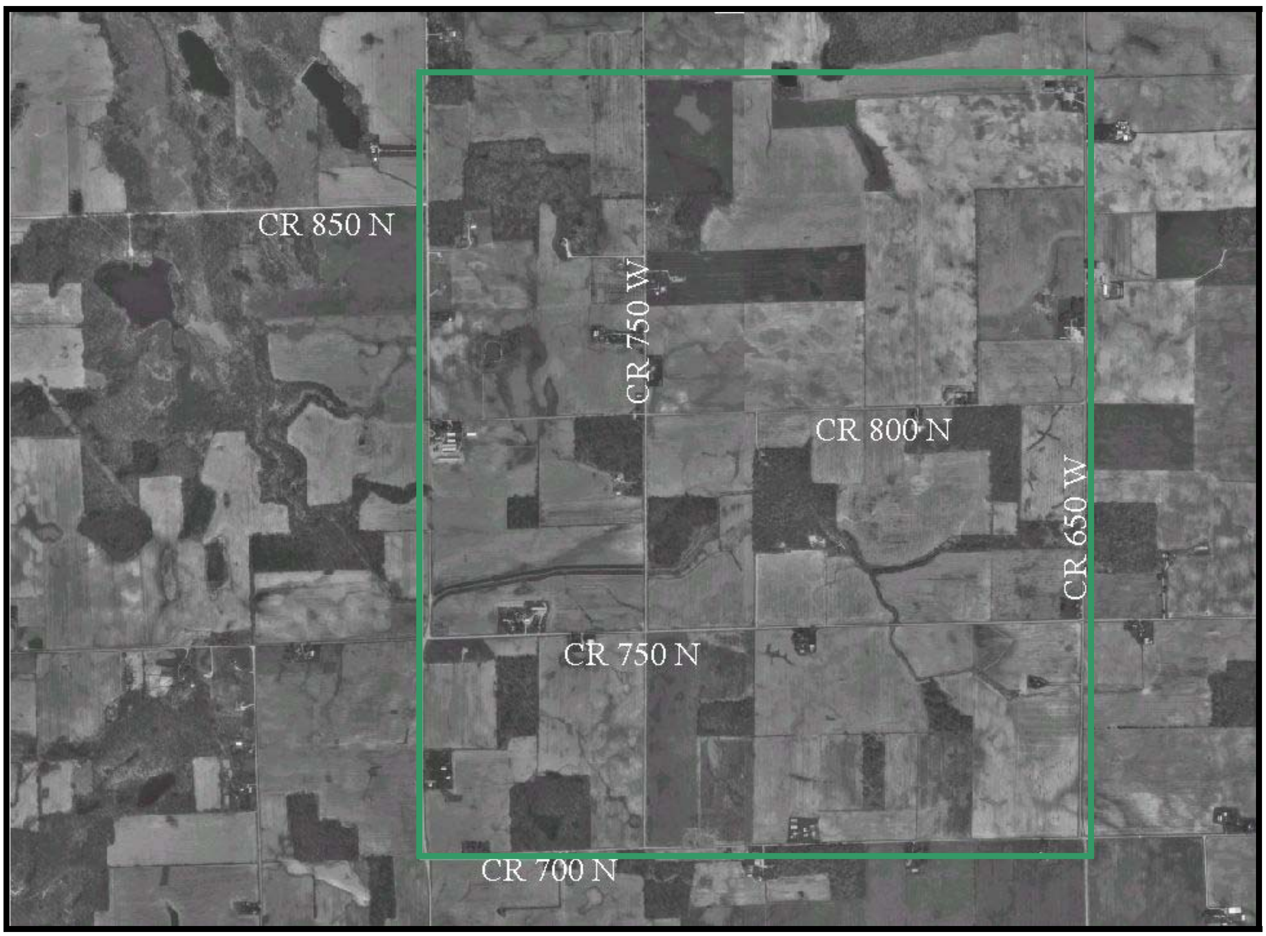


Figure 8. Gaff Ditch headwaters project site.

Using recent aerial photographs and the Kosciusko County Soil Survey, ten potential wetland restoration sites were located within the project area (Figure 9). JFNew contacted each of the landowners associated with potential restoration areas. Concurrently, JFNew met with Amy Lybarger of the Whitley County Natural Resource Conservation Service (NRCS) and two landowners to discuss potential wetland restoration sites. Through this process, all of the potential wetland restoration sites were eliminated due to restoration in progress or already completed on the sites, parcel enrollment in the Wetland Reserve Program (WRP) or other conservation program, or landowners desire to keep the parcel in production.

Figure 9. Potential wetland restoration sites identified in the Gaff Ditch headwaters.

3.2.2 Preliminary Design and Conceptual Drawings

Preliminary designs and conceptual drawings have not been developed. If and when any of the landowners decide to restore part of their property to wetland habitat preliminary designs and conceptual drawings should be developed.

3.2.3 Permit Requirements

No permits are required at this time.

3.2.4 Landowner Agreements

JFNew contacted all landowners in the Gaff Ditch Headwaters with potential wetland restoration sites. Because a specific wetland restoration project is not being pursued at this time landowner agreements are not being pursued.

3.2.5 Wetland Functional Assessment

Wetland functional assessments were not conducted for this project area because a specific wetland restoration project is not being pursued at this time.

3.2.6 Biological and Habitat Integrity Survey

A biological and habitat integrity survey was not conducted for this project area because a specific wetland restoration project is not being pursued at this time.

3.2.7 Environmental Impact Assessment

An environmental impact assessment was not conducted for this project area because a specific wetland restoration project is not being pursued at this time.

3.2.8 Unusual Physical and Social Costs

The loss of productive farmland is the only unusual social cost associated with this project. However, since a project is not being pursued, there are no unusual physical or social costs associated with this project at this time.

3.2.9 Opinions of Probable Cost

Probable costs associated with wetland restoration were not determined during the course of this study.

3.3 STREAMBANK STABILIZATION AND WASCOB CONSTRUCTION, GAFF DITCH AT COUNTY ROAD 750 WEST

3.3.1 Site Description and Alternatives

The project area is located in the Gaff Ditch headwaters at the intersection of Gaff Ditch with County Road 750 West immediately north of County Road 750 North. Gaff Ditch drains 4,020 acres (1,628 ha) of largely agricultural land to the southeast of Webster Lake (Figure 1). The drainage area from the downstream end of the project is 1,325 acres (536 ha). The reach of Gaff Ditch assessed during this feasibility study included approximately 50 lineal feet on either side of the County Road 750 West bridge located in the Whitley County Highway Department right-of-way and on property owned by Eugene Klingaman (Figure 10).

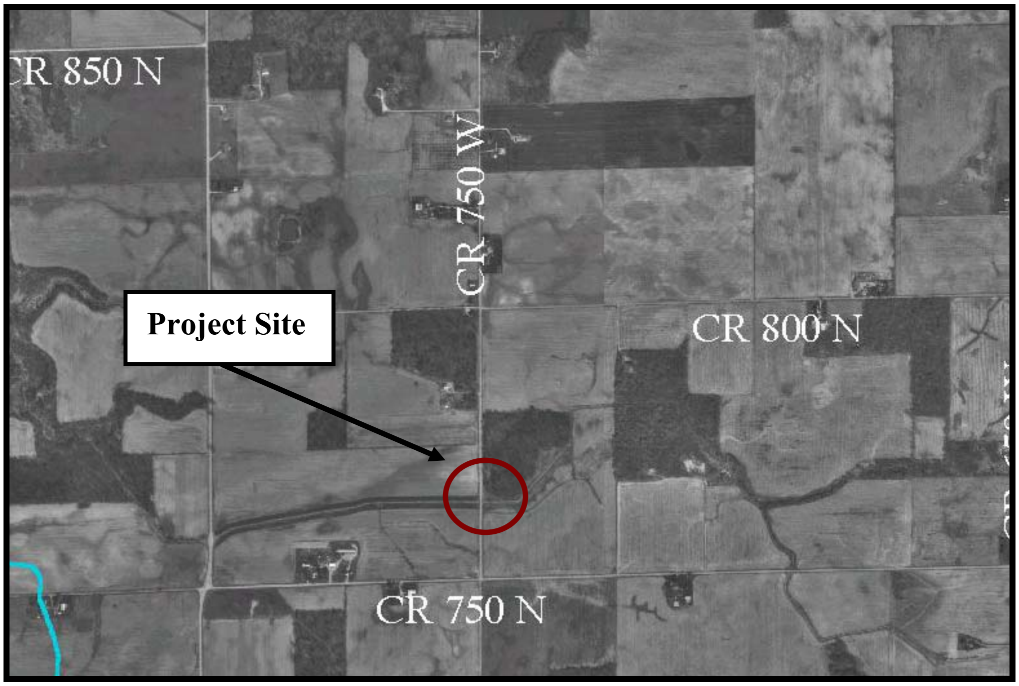


Figure 10. County Road 750 West bank stabilization project location.

The streambanks at the County Road 750 West bridge are severely eroded. (See Appendix A for site photographs.) Figure 11 displays a conceptual drawing of the existing conditions present at the stream's intersection with the bridge. Erosion is occurring on the steep slopes created by the bridge abutment. The erosion is most severe in the northwest corner of the bridge. Erosion is also occurring around an exposed drainage tile near the southeast corner of the bridge contain areas of existing erosion. Overland flow from the adjacent farm field combined with a failing subsurface drainage tile has resulted in gully erosion just east of the bridge on the south side of Gaff Ditch. The gully has an average depth of 4.5 feet and an average width of 6.5 feet. The gully erosion will continue to occur if it is not stabilized. The continued erosion of the gully brings unnecessary sediment to Gaff Ditch (Figure 11).

Alternatives considered for streambank stabilization included: installing rip-rap at each of the eroded bridge corners, creating a water and sediment control basin (WASCOB) at the southeast corner and rip-rap installation at the northwest corner of the bridge, bank shaping and seeding at each of the bridge corners, and leaving the banks in their current condition. Because the Whitley County Highway Department deemed erosion at the northwest corner to be a road maintenance issue, they stated in writing that they would install rip-rap at this location. Likewise, since the landowner of the parcel at the southeast corner was interested in filling the gully and correcting the source of erosion, a WASCOB will be constructed at this location.

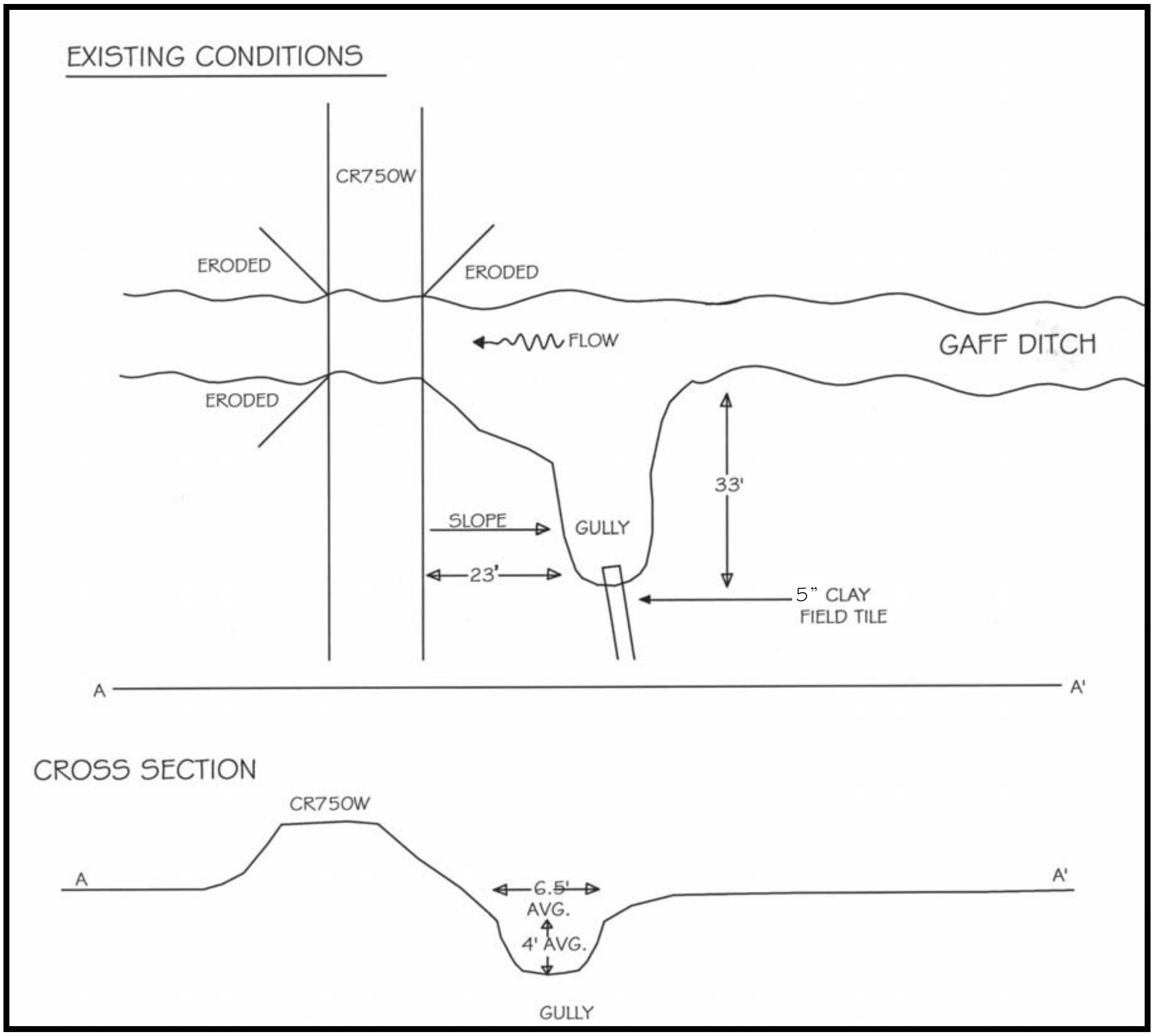


Figure 11. Existing conditions present at the County Road 750 West project site.

3.3.2 Preliminary Design and Conceptual Drawings

The proposed project at the County Road 750 West bridge site consists of two components: 1) bank shaping and rip-rap installation at the northwest corner of the bridge and 2) tile extension, WASCOB creation, and erosion control at the southeast corner of the site. Filter fabric will be installed and covered with approximately 10 tons of rip-rap at the northeast corner of the project site (Figure 12). The Whitley County Highway Department has added this project to their maintenance log and will be responsible for final design and project implementation. (Appendix B contains communication between JFNew and the Whitley County Highway Department Director.) At the southeast corner of the project site, a new tile riser will be installed at the end of the existing tile and the tile will be extended approximately 25 feet using a combination of perforated and solid PVC pipe. The existing gully will be filled with clean earth to a 3:1 slope to create the WASCOB. The slope will then be seeded and blanketed to prevent further erosion (Figure 13). The property owner agreed to hire a contractor to complete the project with the cooperation of the lake association. (Appendix B contains communication between the property owner, JFNew, and the WLCA.)

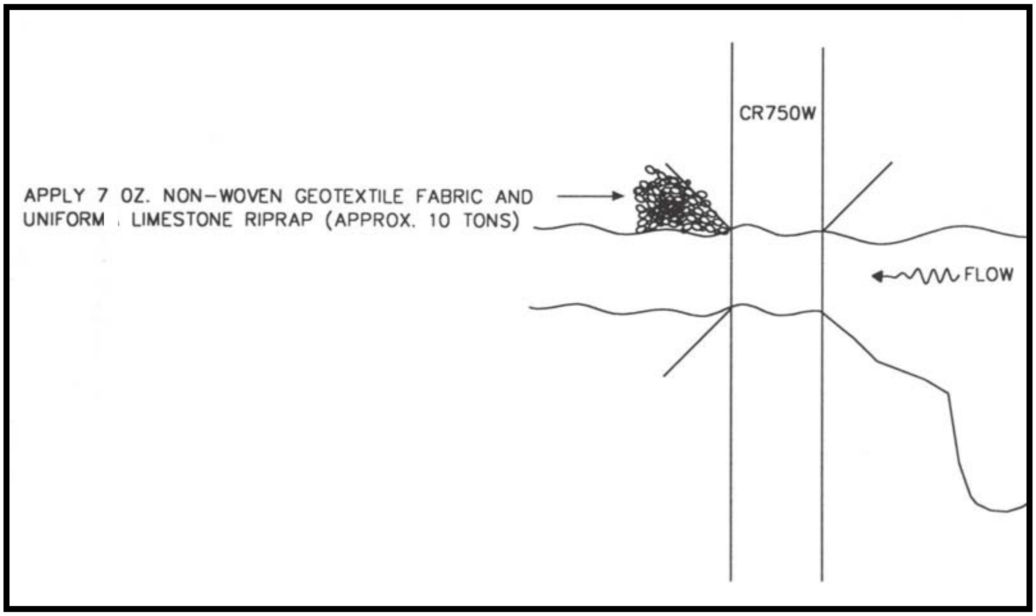


Figure 12. Streambank stabilization conceptual design, northwest corner of County Road 750 West project site.

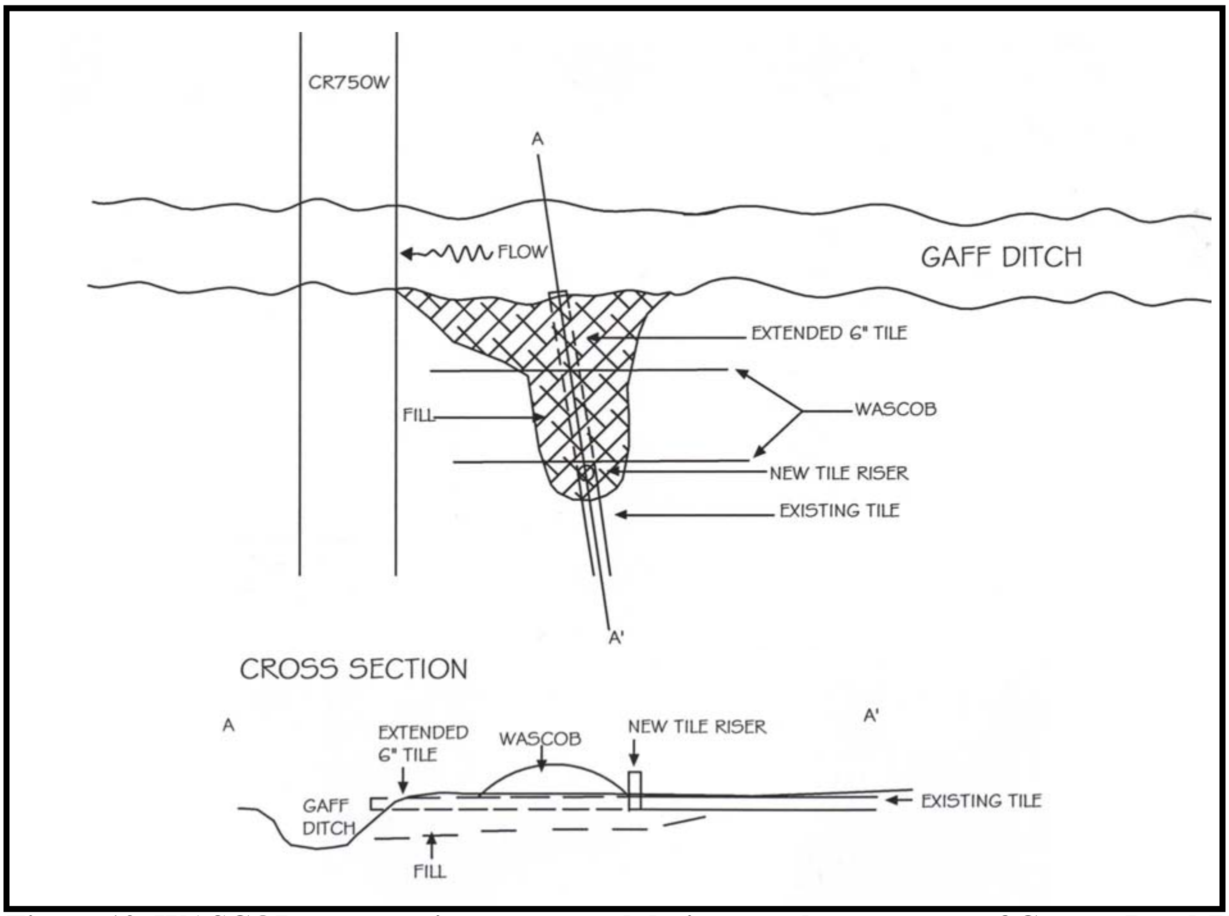


Figure 13. WASCOB construction conceptual design, southeast corner of County Road 750 West project site.

3.3.3 Permit Requirements
Both components of the project will occur outside of the stream channel; therefore, no permits are required for this project. Whitley County is responsible for obtaining any permits necessary for the northwest corner component of the project.

3.3.4 Landowner Agreements
The Whitley County Highway Department has agreed to the preliminary design submitted for the northwest corner of the project site and will develop and implement final designs. The director has added this project to the highway department's maintenance schedule for 2004 (Appendix B). The landowner at the southeast corner of the project site also agreed to the preliminary design and has already contacted a contractor regarding this project.

3.3.5 Wetland Functional Assessment
No wetlands are located within the vicinity of the County Road 750 West project site.

3.3.6 Biological and Habitat Integrity Survey
Because the project will occur outside of the stream channel a biological and habitat survey was not conducted at this site.

3.3.7 Environmental Impact Assessment
Environmental considerations relevant to the proposed project include: wetlands, endangered, threatened, and rare (ETR) species, water quality, flooding, stream habitat, and stream biota. Streambank stabilization and WASCOB construction can proceed with minimal impact to environmental factors. Although an endangered species survey was not conducted as part of this project, the dominant plant species documented at the County Road 750 West project site did not include any state-listed species. Additionally, the IDNR Division of Nature Preserves database does not contain documentation of any ETR plant or animal species in the vicinity of the project site. Because wetlands are not located in the vicinity of the project site, it is expected that there will be no impact to wetlands. Since the project is occurring outside of the channel, flooding will not be a concern associated with this project. Sediment and sediment-attached pollutant loading from the site will decrease with a concurrent improvement in water quality. Rip-rap installation and WASCOB construction will also prevent further streambank and gully erosion and the water quality degradation that results from the introduction of sediment and sediment-attached pollutants to Gaff Ditch. Since the project will occur outside of the stream channel, neither stream habitat not stream biota will be impacted by the project.

3.3.8 Unusual Physical and Social Costs
Unusual physical costs associated with construction of this project include: project access and maintenance. The County Road 750 West bridge is narrow, which limits mobility and access at the site. Traffic flow issues must be considered when project construction occurs.

3.3.9 Opinions of Probable Cost
The Whitley County Highway Department is including streambank stabilization at the northwest corner in their maintenance schedule and budget. The landowner of the southeast corner property plans to hire a contractor to complete the work with reimbursement to come from the Webster

Lake Conservation Association. An opinion of probable cost was $1,000 for this component of the project.

3.3.10 Project Justification and Estimation of Impact

Although streambank erosion is a natural process, drainage practices in the Gaff Ditch Subwatershed have artificially exacerbated the process. Artificial drainage of the Gaff Ditch Subwatershed landscape increases the volume and velocity of water delivered to and flowing through the channel during storm flow events. During high discharge events, rapid flows erode streambanks. The steep banks, like those at the County Road 750 West project site, are prone to mechanical bank failure, resulting in the deposition of bank material at the base of the bank where base flow discharges can carry the material downstream (Waters, 1995). As the slumped material is removed, bank slope is again increased and the process repeats itself. Cultural processes like artificial drainage exacerbate the problem by increasing the amplitude of discharge events. Streambank erosion was identified as an important contributor to net sediment loading. Additionally, in some cases researchers have attributed >50% of the sediment load carried by small streams in the Midwest to channel erosion (Roseboom and White, 1990; Isenhart et al., 1997). The proposed project is necessary considering that the goal is ultimately to reduce the delivery of nutrient rich sediments to Webster Lake, and all feasible actions to reduce sediment release from the watershed must be attempted prior to securing in-lake treatment funding.

3.4 STORM DRAINS, WEBSTER LAKE AND THE BACKWATERS AREA

3.4.1 Drain Descriptions

The project area includes land drained by county-regulated storm drains including the lakeshore from 1st Trail around the east and south sides of the Webster Lake to EMS W31 Lane. The storm drains within the Town of North Webster (Drains 1-18) are not included in this study since they were documented in the 2002 North Webster Storm Drain Engineering Feasibility Study (JFNew, 2002). The residential properties occupy areas of the watershed draining directly to the lake on its north, east, and south sides. Residential runoff carries yard waste, fertilizer, and other debris to the lake via storm drains. Pollution from these drains was not directly categorized or quantified but varies at each drain. For example, at least one storm drain carries sand, gravel, and road salt from wintertime applications of these pollutants to the adjacent roads; other storm drains likely release sediment, sediment-attached nutrients, pesticides, yard debris, and garbage. Most of the drains examined could be improved in some way to reduce their respective pollutant loads to the lake.

JFNew conducted two site visits on June 24 and July 17, 2003 identifying fifty-one storm drains, thirty-three of which are under the jurisdiction of Kosciusko County (Appendix C). A majority of the storm drains located during this study were constructed by individual landowners. Generally, residents designed their drains based on the location of standing water on or near their property at the time of construction. Most of these drains were sized to reduce the depth and duration of water ponding and consist of a grated metal or cement inlet structure connected to a plastic, clay, or metal pipe which conveys water directly into the lake. The general design of an inlet to a pipe flowing directly to the lake provides little to no stormwater pollutant reduction and often does not allow for drain cleaning or maintenance.

Many of the drains in the northwest corner of the lake area fitted with typical box drop structures also known as catch basins. Many of these structures and their grated inlets were full, nearly full, or clogged with sand, debris, lawn litter, trash, and other debris. Current research indicates that when sediment and debris fill more than 60% of the catch basin volume, the basin reaches “steady state” meaning that the basin no longer removes sediment from stormwater runoff (Pitt and Bissonnette, 1984). In catch basins that are more than 60% filled, storm flows entering these basins re-suspend sediments in the basin and pass them through the system.

Each of the storm drains leading to Webster Lake and the Backwaters from the public roads identified during the duration of this study are listed in Table 4. (Appendix C contains field observations and photographs taken during the storm drain field survey.) More drains probably exist but were not located during the survey. If additional storm drains are located in the future, the general pollution reduction techniques prescribed for the identified drains will likely be applicable to drains identified in future surveys.

Table 4. Storm drains identified along the shoreline of Webster Lake and the Backwaters.

Drain Network	Drain Description	Potential Treatment
1-18	See North Webster Storm Drain Engineering Feasibility Study (JFNew, 2002) for descriptions.	See North Webster Storm Drain Engineering Feasibility Study (JFNew, 2002) for treatment potential.
19	three open drainage channels flow to three 8-10” corrugated metal pipes flow, then into a 12” corrugated metal pipe	Plant open drainage channels as a vegetated swale.
20	2 ft^2 rectangular metal grated inlet and a 6” plastic pipe to a 6” plastic pipe	Clean grating and catch basin.
21	12” circular metal grated inlet; outlet could not be located	No recommended action at this time.
22	12” circular metal grated inlet; outlet could not be located	No recommended action at this time.
23	2 ft^2 rectangular metal grated inlet and roadside gravel drainage channel to an 8” plastic pipe	Clean grating and catch basin; replace grate; plant roadside channel as a vegetated swale.
24	12” circular cement grated inlet; outlet could not be located	No recommended action at this time.
25	roadside cement and gravel swale	Plant swale with vegetated swale seed mix.
26	14” circular metal grated inlet and overland flow originating from 6” plastic pipe to metal pipe of indeterminate size	Remove drain and replace with correctly sized catch basin and drop structure.
27	8” circular metal grated inlet to a 10” plastic pipe	Resize pipe; plant vegetation around grated inlet.
28	24” circular metal grated inlet to a 12” corrugated metal pipe	Remove debris from grated structure; plant vegetation around grated inlet.

Drain Network	Drain Description	Potential Treatment
29	8" square metal grated inlet to a 6" metal pipe which outlets onto grass; overland flow to the lake	Plant vegetation around grated inlet.
30	roadside drainage to 12" corrugated metal pipe; outlet could not be located	Remove debris from pipe.
31	12" square metal grated inlet though 10" corrugated metal pipe to 12" round metal grated inlet; a second 12"corrugated metal pipe also empties into 12" round inlet; all outlet through two 4" plastic pipes	Install correctly sized grate on north drain inlet.
32	roadside gravel drainage channel to 8" corrugated metal pipe which empties into a brick-lined swale	Plant vegetation around pipe; replace brick-line swale with vegetated swale or gravel/cobble infiltration trench.
33	10" circular metal grated inlet to 10" corrugated metal pipe; passes from pipe into boulder-line, gravel-filled trench with a 6" plastic perforated pipe running underneath; pipe outlets into a 12" by 18" rectangular metal grated inlet; outlets through a second 6" plastic pipe which empties into onto grass running as overland flow approximately 15' to the shoreline	Replacement and cleaning of 12" by 18" rectangular grated inlet.
34	boulder-lined, gravel-filled trench with a 6" plastic perforated pipe running underneath; pipe outlets into a 12" square metal grated inlet; outlets through a 6-8" plastic pipe which empties into another gravel-lined trench approximately 10' from the shoreline	Regular maintenance and cleaning.
35	surface drainage channel to 10" corrugated metal pipe to a 14" round metal grated inlet; exits structure through 8-10" corrugated metal pipe to a 12" square metal grated inlet; empties through a 4-6" plastic pipe	Clean grating and drop structure. Regular maintenance of drop structure.
36	14" circular metal grated inlet to 12" clay pipe	Clean grating.
37	14" circular metal grated inlet to a 12" clay pipe	Clean grating.

Drain Network	Drain Description	Potential Treatment
38	two 15' by 2' rectangular metal grated inlets, a 25' by 2' metal grated inlet, and a 6" plastic pipe to a gravel filled hole; exits through a 10" plastic pipe and outlets onto gravel/grass; overland flow to lake	Plant and reshape outlet as a vegetated swale; install gravel/cobble to shoreline.
39	cement depression to a 6" plastic pipe; a 6" and 10" clay pipe and a 12" plastic pipe carry water downhill to the lake; 6" plastic pipe outlets though seawall at lake	Install correctly sized catch basin. Regular maintenance of catch basin.
40	12" circular metal grated inlet; outlet could not be located	No recommended action.
41	6" square metal grated inlet to a 4" plastic pipe	Clean grating.
42	14" circular metal grate and a 12" plastic pipe to a 12" plastic pipe	No recommended action.
43	12" by 8' driveway grate through three 2-4" plastic pipes to a 4-6" plastic pipe; pipe empties into a 14" square plastic grated inlet; exits through a 6" plastic pipe to a concrete swale	Install StreamGuard; replace concrete channel with gravel/cobble infiltration trench.
44	concrete swale, 10" square metal grated inlet, and an 8" plastic pipe to an 8" square metal grated inlet; exits through a 12" plastic pipe to a concrete swale	Replace blacktop swale with gravel/cobble infiltration trench or vegetated swale.
45	concrete swale and 3" plastic pipe to concrete swale	Replace cement with gravel/cobble infiltration trench or vegetated swale.
46	two 3" by 8' driveway grates to a 4" plastic pipe	Regular drain cleaning; install StreamGuard.
47	cement depression to a 4" plastic pipe	Regular drain cleaning and maintenance.
48	12" circular cement grated inlet through a 10" plastic pipe to an 18" circular metal grated inlet; exits the drain through a 10" plastic pipe	Clean grating; regular drain maintenance.
49	14" circular metal grated inlet through a 10" corrugated metal pipe to a 10" circular metal grated inlet; exits though an 8" plastic pipe	No recommended action.
50	10" clay tile to an 18" square metal grated inlet to a 10-12" clay pipe	Repair broken tile and fill blow hole.
51	18" square metal grated inlet though a 12" clay pipe to an 18" square metal grated inlet; exits through a 10" clay pipe	Regular maintenance and cleaning.

3.4.2 Easement and Land Availability Determination

A majority of the inlets for the thirty-three drains examined fall within the right-of-way of county roads. However, since storm drain projects are not currently proposed, JFNew did not meet with the County Highway Engineer (Rob Ladson) to discuss the problems these drains cause or potential solutions to any problems. Individuals should meet with the County Engineer prior to any work being proposed or completed on these drains. During a meeting regarding storm drains at another Kosciusko County lake, Mr. Ladson agreed that the county is responsible for cleaning and maintaining all existing structural catch basins within the county right-of-way. Furthermore, Mr. Ladson explained that most of the catch basins had not been cleaned in the past because they had not been placed on the county maintenance schedule. Landowners at Webster Lake confirmed that the county cleaned Drain 50 during March or April 2002 (personal communication). The county commissioners have jurisdiction over all work in the right-of-way and the authority to regulate that work through the County Engineers Office to the County Highway Department. Mr. Ladson also indicated that he would not support the installation of additional stormwater inlets that would require maintenance, as the crews cannot maintain the existing stormwater drainage system. Mr. Ladson did, however, support the idea of constructing infiltration trenches and grassed swales since these structures require less management.

3.4.3 Preliminary Design and Conceptual Drawings

Table 4 lists potential treatment options that would reduce pollutant loading to the lake via storm drains. No recommended modifications to drain structures are being made at this time; therefore, no preliminary designs or conceptual drawings are included. Information regarding regular catch basin cleaning and the StreamGuard inserts, which would help reduce pollutant loading to Webster Lake, can be found in the North Webster Storm Drain Engineering Feasibility Study (JFNew, 2002).

3.4.4 Permit Requirements

Modifications to the existing storm drain infrastructure are not being considered at this time. However, if modifications are suggested in the future, the projects will require permits from the Kosciusko County Highway Department as they lie within the county right-of-way. State or federal permits are not required for these types of projects.

3.4.5 Landowner Agreements

Recommendations for storm drain structure modification are not being considered at this time. No formal written agreements were established with landowners regarding potential storm drain projects. If any projects are proposed in the future, then conceptual plans should be presented to property owners before funding or county permits are obtained.

3.4.6 Environmental Impact Assessment

Modifications to storm drain structures are not being considered at this time, so no environmental impact assessment was conducted as part of this feasibility study. The environmental impacts of any projects that do occur in the future should be considered. However, since most of the work associated with storm drains would occur in or near residential lawns, roadside ditches, roads, or concrete catch basins, it is unlikely that negative environmental impacts will occur. Impacts to water quality could only be positive given the conditions of the drains during the study inspections. Any potential projects proposed in the future should be examined for impacts to wetlands, ETR species, water quality, flooding, stream habitat, and stream biota.

3.4.7 Unusual Physical and Social Costs

Modifications to storm drain structure are not currently being proposed; therefore, unusual physical or social costs that could be associated with storm drain projects were not evaluated.

3.4.8 Opinions of Probable Cost

Storm drain modifications are not being considered at this time; however, potential treatments are listed in Table 4. Table 5 contains cost estimates for the treatments listed in Table 4. Opinions of probable costs are provided on a per item or per lineal foot basis. Specific costs for each of the potential drain improvements are not calculated.

Table 5. Opinions of probable cost for potential storm drain treatments.

Potential Treatment	Opinions of Probable Cost
Tile replacement	$5 per lineal foot
Infiltration trench construction	$5 per lineal foot
Cleaning (vactor truck operation and maintenance)	$1000 per cleaning
Utility personnel for cleaning or maintenance	$20 per hour
Material disposal	$500 per cleaning
StreamGuard inserts	$82 per insert
Swale seed mix	$485 per acre
Grate replacement	$100 per grate
Drop structure replacement	$1,500-2,500*

*Final cost will depend upon costs for drop structure removal and disposal, concrete removal and replacement, and any engineering work needed to calculate replacement structure size.

3.4.9 Project Justification and Estimation of Impact

The storm drains were not sampled for pollutant export; therefore only limited conclusions can be drawn on the amount of pollutants that these drains are delivering to Webster Lake and the Backwaters and what impact the proposed solutions will have. Road salts, nutrients from adjacent lawns and leaf litter, and hydrocarbons are going directly to the lakes as they are washed from the roads. Properly maintained catch basins have been found to remove 32-97% of total suspended solids (Pitt et al., 2000; Mineart and Singh, 1994). Wetland vegetated filters have been found to remove between 40-90% of hydrocarbons, nutrients, and sediment from runoff (Moustafa, 1997; Wang and Mitsch, 1996; Warwich et al., 1998). Projects vary in efficiency due to size and type of construction as well as the age of filters. Mature wetland filters absorb fewer pollutants than newly constructed filters. This study assumes that the storm drains around the lake play a minor role in the delivery of pollutants to the lakes. However, the drains are contributing pollutants and the cost of treatment is relatively low compared to some of the other issues identified throughout the watershed, therefore treatment is recommended.

4.0 RECOMMENDATIONS

1. Apply for a LARE grant in 2004 for design and construction of the sedimentation basin project on Bart Culver's property. Begin construction of the project following removal of the fall crop.

2. Implement WASCOB construction project once a bid is received from a contractor.

3. Pursue funding to address maintenance and cleaning of existing storm drains under Kosciusko County jurisdiction.

4. Begin exploring water quality improvement projects in the Tippecanoe River Subwatershed. Potential projects are identified in both the Upper Tippecanoe River Basin Watershed Management Plan (TELWF, 2002) and in the Draft Smalley Lake Diagnostic Study (JFNew, 2004).

5.0 LITERATURE CITED

Aquatic Control. 2002. Aquatic Plant Management Study and Plan. Conducted by SePro and Aquatic Control. Indiana Department of Natural Resources, Division of Soil Conservation, Lake and River Enhancement Program, Indianapolis, Indiana.

CLP. 2003. Indiana Clean Lakes Program data files – 1991, 1994, 1998, 2003. School of Public and Environmental Management, Indiana University, Bloomington.

Crisman, Thomas L. 1993. Assessment of Watershed-Lake Interactions Influencing the Cultural Eutrophication of Little Crooked and Crooked Lakes, Indiana. Loose-leaf publication, 100 pp.

Cummings, K.S., C.A. Mayer, L.M. Page and J.M.K. Berlocher. 1987. Survey of the Freshwater Mussels (Mollusca: Unionidae) of the Wabash River Drainage Phase I: Lower Wabash and Tippecanoe Rivers. From: Faunistic Surveys and Insect Identification Technical Report 1987 (5). Illinois Natural History Survey and Indiana Department of Natural Resources, Indianapolis, Indiana.

Ecological Specialist, Inc. 1993. Mussel Habitat Suitability and Impact Analysis of the Tippecanoe River. Indiana Department of Natural Resources and U.S. Fish and Wildlife Service.

Fisher, B. 1998. Natural Mussel Survey. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

F.X. Browne Associates, Inc. 1992. Feasibility Studies of Loon Lake and Goose Lake. Loose-leaf publication, 128 pp.

Hippensteel, P. 1989. Preliminary Investigation of the Lakes of Kosciusko County. Tri-State University, Angola, Indiana.

Homoya, M.A., B.D. Abrell, J.R. Aldrich, and T.W. Post. 1985. The natural regions of Indiana. Indiana Academy of Science, Vol. 94, Indiana Natural Heritage Program, Indiana Department of Natural Resources, Indianapolis, Indiana.

Indiana Department of Environmental Management. 1986. Indiana Lake Classification System and Management Plan. Indiana Department of Environmental Management, Indianapolis, Indiana.

Indiana Department of Environmental Management. 2001. Tippecanoe River Watershed Restoration Action Strategy. Indiana Department of Environmental Management, Indianapolis, Indiana.

Indiana Department of Natural Resources Division of Soil Conservation. 1995. A Preliminary Assessment of Big Lake, Noble County (1993-1995). Indiana Department of Natural Resources, Division of Soil Conservation, Indianapolis, Indiana.

Isenhart, T.M., R.C. Schultz, and J.P. Colletti. 1997. Watershed restoration and agricultural practices in the Midwest: Bear Creek of Iowa. In: Williams, J.E., C.A. Wood, and M.P. Dombeck (eds.) Watershed Restoration Principles and Practices. American Fisheries Society, Bethesda, Maryland, p. 318-334.

J.F. New & Associates, Inc. 2000. Webster Lake/Backwaters Area Diagnostic Study. Indiana Department of Natural Resources, Division of Soil Conservation, Lake and River Enhancement Program, Indianapolis, Indiana.

J.F. New & Associates, Inc. 2002. North Webster Storm Drain Engineering Feasibility study. Indiana Department of Natural Resources, Division of Soil Conservation, Lake and River Enhancement Program, Indianapolis, Indiana.

JFNew. 2004. Draft Smalley Lake Diagnostic Study. Indiana Department of Natural Resources, Division of Soil Conservation, Lake and River Enhancement Program, Indianapolis, Indiana.

Mineart, P. and S. Singh. 1994. Storm inlet pilot study. Alameda County Urban Runoff Clean Water Program, Oakland, CA.

Moustafa, Mohammed. December 1997. A Graphical Representation of Nutrient Removal in Constructed Wetlands. Wetlands. V.17, No.4, P. 493-501

Omernik, J.M. and A.L. Gallant. 1988. Ecoregions of the upper Midwest states. EPA/600/3-88/037. U.S. Environmental Protection Agency, ERL, Corvallis, Oregon.

Pearson, J. 1985. Lake Webster, Kosciusko County, fish management report. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Pearson, J. 1987. Muskie Fishing Interest and harvest at Lake Webster, Indiana. Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Pearson, J. 1989. Lake Webster, Kosciusko County, fish population survey. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Pearson, J. 1991. Abundance, angler utilization and impacts of muskellunge at Lake Webster. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Pearson, J. 1995. Lake Webster, Kosciusko County, fish management report. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Pearson, J. 1999. Muskellunge population characteristics at Lake Webster, Indiana. Indiana Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Pearson, J. 2000. Movement of radio-tagged muskellunge in Lake Webster, Indiana. Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Pitt, R. and P. Bissonnette. 1984. Bellevue urban runoff program summary report. U.S. Environmental Protection Agency, Water Planning Division, Washington, DC.

Pitt, R., M. Lilburn, S. Nix, S.R. Durrans, S. Burian, J. Voorhees, and J. Martinson. 2000. Guidance manual for integrated wet weather flow collection and treatment systems for newly urbanized areas. U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, OH.

Roseboom, D.P. and W. White. 1990. The Court Creek restoration project: erosion control technology in transition. Pages 25-40 in Proceedings of XXI conference of the International Erosion Control Association. IECA, Steamboat Springs, Colorado.

Shipman, S. T. 1976. Webster Lake fish management report. Department of Natural Resources, Division of Fish and Wildlife, Indianapolis, Indiana.

Simon, T. 1997. Development of index of biotic integrity expectations for the ecoregions of Indiana. III. Northern Indiana Till Plain. EPA 905/R-96/002. U.S. Environmental Protection Agency, Region V, Water Division, Watershed and Non-Point Source Branch, Chicago, Illinois.

Staley, L. R. 1989. Soil Survey of Kosciusko County, Indiana. United States Department of Agriculture, Indianapolis, Indiana.

TELWF. 2002. Upper Tippecanoe River Watershed Management Plan. Loose-leaf publication, 100+ pp.

The Nature Conservancy. 2001. Tippecanoe River Project Strategic Plan, Draft. Loose-leaf publication, 12 pp.

United States Environmental Protection Agency. 1976. Report on Webster Lake, Kosciusko County, Indiana, Indiana. EPA Region V Working Paper No. 345.

United States Army Corps of Engineers. 1995. Upper Tippecanoe River Basin Kosciusko County, Indiana. Interim Reconnaissance Report Volume 1 and 2. Loose-leaf publication, 300 pp.

Wang, N., W.J. Mitsch. 1996. Estimating Phosphorus Retention of Existing and Restored Wetlands in the Quanicassee River Watershed. Great Lakes Wetlands. V.7 No. 1

Warwick, J.J., D. Spinogatti, T. Jones. 1998. Evaluating the Efficacy of Artificial Wetlands for Tertiary Treatment. Wetlands Engineering and River Restoration Conference.

Waters, T.F. 1995. Sediment in streams: sources, biological effects, and control. American Fisheries Society Monograph 7.

APPENDIX A:

PROJECT SITE PHOTOGRAPHS

Site Photographs
Sedimentation Basin Installation
Culver Property
Webster Lake Engineering Feasibility Study

Site Photographs
Streambank Stabilization
Gaff Ditch Headwaters, CR 750 West
Webster Lake Engineering Feasibility Study

APPENDIX B:

COMMUNICATION WITH LANDOWNERS

JFNew
Wise Growth Through Stewardship

708 Roosevelt Road
Walkerton, Indiana 46574
one: 574-586-3400 ext. 307
Fax: 574-586-3446

John B. Richardson
Senior Project Manager
ail: jrichardson@jfnew.com

Corporate Office:
Walkerton, Indiana

Crete, Illinois

Indianapolis, Indiana

Grand Haven, Michigan

Cincinnati, Ohio

Native Plant Nursery:
Walkerton, Indiana

www.jfnew.com

January 22, 2004

Bart Culver
P.O. Box 294
North Webster, Indiana 46555

Dear Mr. Culver:

Thank you for meeting with us in late November on your property adjacent to Epworth Forest Road in North Webster, Indiana. As you are aware, JFNew is working with the Lake Webster Conservation Association (LWCA) to complete an engineering feasibility study on projects to improve water quality in the lake. This project and subsequent design and construction of any solutions will be funded predominantly by grants from the Indiana Department of Natural Resources Lake and River Enhancement Program with matching funds provided by the LWCA.

As we discussed, it was decided that some benefit could be gained by construction of a small basin as the water exits your property through a 5-6 inch diameter clay tile size and a 12-inch diameter pipe under Epworth Forest Road. The conceptual design on the attached page would capture both overland flow and the subsurface tile flow before the water leaves your property. The final design will designate a permanent pool elevation equal to the invert of the clay tile and a bottom depth eight feet below permanent pool level. The basin would serve as a sediment collection basin and for storm water storage of the farm field. The basin and proposed prairie buffer would not affect the size of your existing crop field as it is designed entirely within your existing buffer area along Epworth Forest Road.

If you agree with this concept plan for your Epworth Forest Road property please sign below and return a copy to me in the envelope provided. Signing this supports our efforts to obtain additional grant money for final design and construction funding. We welcome any suggested changes you might have at this time, so please feel free to write comments on the draft plan and return them to me. Please call me if you have any immediate concerns or questions. Thank you for your consideration.

60-70 feet entrance for future road off of EPWORTH FOREST RD. needs to be allowed for. Pond may need to run other direction

Sincerely,

John Richardson

Name:______________________ Date:____
I agree with the above concept plan

Attachment: Concept Plan

C: Dawn Meyer, LWCA,
JF New file 98-04-25/03

Bart Culver

WHITLEY COUNTY HIGHWAY

October 29, 2003

JF New
John Richardson
708 Roosevelt Road
Walkerton, IN 46574

RE: County right-of-way erosion on 750 W at the Gaff Ditch

Dear Mr. Richardson,

The County Engineer and I looked at the area that you wanted rip rap and filter fabric placed. It is our contention that the NW corner of the structure is the only area that needs attention at this time. I will place this on our schedule for repair.

If you have, any questions concerning this matter please contact me at (260) 248-3123.

Respectfully,

Randall L. Knach, Director
Whitley County Highway

801 SOUTH LINE STREET • COLUMBIA CITY, IN • 46725
PHONE: (260) 248-3123 • FAX: (260) 248-3125

APPENDIX C:

WEBSTER LAKE AND THE BACKWATERS AREA STORM DRAIN MAP

The storm drain map is not included with the electronic version of this report. Copies of the storm drain map can be obtained from the Indiana Department of Natural Resources Division of Fish and Wildlife Lake and River Enhancement Section Office.

APPENDIX D:

FIELD OBSERVATIONS AND PHOTOGRAPHS
WEBSTER LAKE AND BACKWATERS STORM DRAINS

Appendix D. Webster Lake Stormwater Drain Survey

Drain 19: Drain 19 is located at the bend near 100 EMS Lane W30A1 on the northwest side of the road. The drain's inlet is currently a hole in the yard where three drain pipes converge. The landowner has covered the hole with a planter measuring 2 feet in diameter. Three 8-10 inch corrugated metal pipes converge at this point from the southwest, southeast, and northeast. The southwestern pipe is a 10-inch pipe which runs southwest along W30A1 draining yards adjacent to the lake. The southeastern pipe is an 8-inch pipe which runs underneath W30A1 collecting water from yards and the road opposite the lake. The northeastern pipe is a 10-inch pipe which passes underneath W30A1 and collects yard and road drainage from opposite the lake. A 12-inch corrugated pipe runs approximately 200 feet northwest from the convergence to Webster Lake. The outlet pipe is partially blocked with leaves and grass clippings; however, water can exit through the concrete seawall with little difficulty.

Catch basin for Drain 19.

Outlet pipe for Drain 19 at Webster Lake.

Drain 20: Located at 197 EMS Lane W30A1. The inlet to Drain 20 is on the northwest side of the road west of the driveway. Drain 20 has a 1-foot by -foot rectangular grated inlet. The drain accepts water from a 6 inch plastic pipe coming from the southeast. Water exits the drain through a 6 inch plastic pipe which passes on the northeast side of the house and carries water approximately 250 feet northwest to Webster Lake. The pipe empties water from behind a shrub onto a concrete swale. Water then passes from the swale over the seawall before entering the lake.

Grated inlet at Drain 20.

Outlet pipe (behind bush) for Drain 20 at Webster Lake. Water passes from the swale over a seawall and into Webster Lake.

Drain 21: Drain 21 is located at 51 Lane W29B on the south side of the road near the west edge of the driveway. The drain inlet has a 12-inch round grated drain. The drain accepts water from a 4 inch plastic pipe from the southeast. Another 4-inch plastic pipe exits the drain flowing south toward Webster Lake. An outlet at the lake could not be located at the time of the field survey. It is believed that when the timber seawall was constructed the pipe was blocked. Rill erosion adjacent to W29B suggests that water runs along the road during storm events; however, there did not appear to be evidence that water typically ponds in or near the driveway, so the drain may still be functioning in some capacity.

Grated inlet to Drain 21.

Drain 22: Located at 32 W29B on the south side of the road near the northwest edge of the driveway. The drain's inlet is a 12-inch circular grated cover in a concrete driveway. No inlet pipes could be identified at this drain. A 4-6-inch plastic pipe exits the drain to the southeast running nearly 100 feet to the lake. An outlet pipe could not be located at the lakeshore; a newly constructed concrete seawall is likely blocking the pipe's exit at Webster Lake.

Grated inlet to Drain 22.

Drain 23: Drain 23 is located at the top of the hill east of the intersection of Lanes W30A1 and W29B. The drain's inlet has a 1-foot by 2-foot grated rectangular cover. Water collects in a gravel drainage channel which runs southeast along W29B before entering an 8 inch plastic pipe. The drain also accepts water from an 8-inch plastic pipe from the east. Water exits the drain through an 8 inch metal pipe. Somewhere between the outlet of the catch basin and the outlet at Webster Lake the pipe has been replaced with a 4-6 inch plastic pipe. The exact location of the change in pipe size and material could not be determined during the field survey. In total, the water runs approximately 150 feet northwest before emptying into Webster Lake.

Grated inlet for Drain 23.

Drainage channel along southeast side of W29B adjacent to the road.

Outlet pipe for Drain 23 at Webster Lake.

Drain 24: Drain 24's inlet is located in a gravel area between 27 and 35 EMS Lane W26 on the west side of the road. The inlet has a 12-inch cement grated cover. The exact location of pipes entering the drain could be seen during the time of the field survey. It is believed that a 4-6-inch plastic pipe exits the drain to the west. The pipe runs nearly 200 feet before ending at a channel to Webster Lake. The outlet of the pipe could not be located; however, a landowner in the area indicated that she had observed water flowing from underneath the lake-side dock during storm events. The pipe's outlet could not be located underneath the structure; however, a large pile of loose sediment, grass clippings, and leaves were piled underneath the structure at the time of the survey.

Grated inlet to Drain 24.

Drain 25: Water drains from the hill at the top of Backwaters Drive into a cement and gravel swale. The swale directs water from the north side of the road away from the roadside, behind a set of mailboxes, down the hill adjacent to the lake, and into the channel between the Backwaters and Webster Lake. The landowner from across the road indicated that water in this drain is typically flowing very fast during storm events.

Cement and gravel swale adjacent to Backwaters Drive near CR 900 East.

Drain 26: Drain 26's 14-inch grated inlet is located at the end of EMS W23 in the center of the road. The inlet is cemented into the road. This drain receives overland flow from a 4-6-inch plastic pipe which drains the northern section of CR 900 East before running 25 feet down the hill to the west of the drain. Drain 26 receives overland flow from the hill on W23, the hilly area along Backwaters Drive, and the property at the end of the W23. The tops of two pipes could be seen through the grate opening, but their exact location and drainage areas could not be determined due to an accumulation of sediment, grass clippings, and leaves in the drain's catch basin. A metal pipe of indeterminate size flows 75 feet east emptying into a vegetated area in The Backwaters. The owner of the property at the end of W23 indicated that the drain receives large amounts of water during storm events, and typically, "coffee colored" water flows from the drain pipe into the Backwaters. He indicated that water does not normally pond at the end of the road during storm events but that the drain receives a lot of water.

Grated inlet to Drain 26.

Drain 27: The drain's inlet is located at 144 EMS Lane 23A. The drain's inlet is covered by an 8-inch grate. Water flows from across and along the road before entering the drain. A 10-inch plastic pipe exits the drain and flows northeast approximately 50 feet into The Backwaters. The landowner indicated that he built the drain less than a year ago. Despite the storm drain, water still ponds in his driveway and around his house. The landowner requested information and indicated that he would contact Dawn Meyer or Lynn Stevens to attempt to improve the current situation.

Grated inlet to Drain 27.

Outlet to Drain 27 at The Backwaters.

Drain 28: The drain is located at the IDNR Public Access Site along the south side of Backwaters Drive. The 24-inch grated inlet is nearly two-thirds covered in gravel, grass, and leaves. It could not be determined at the time of the survey the exact number of pipes, if any, that connect to this drain. A 12-inch corrugated metal pipe exits the drain to the east running approximately 75 feet under the parking lot before emptying into a marshy area adjacent to the parking lot and Backwaters Drive. The pipe drops water approximately 5 feet into the water. Erosion is likely not an issue here due to the abundant vegetation at the pipe's outlet which limits the velocity with which the water impacts the adjacent shoreline.


Grated inlet to Drain 28.


Outlet pipe from Drain 28 to The Backwaters.

Drain 29: The drain's inlet is located at 400 EMS Lane W19. The drain's inlet is currently an 8-inch by 8-inch square grated inlet. The grate is partially covered by leaves, dirt, and grass. The drain receives water from a 6-inch metal pipe which flows underneath W19 from a drainage channel running along the east side of the road. A 6 inch metal pipe exits the drain flowing approximately 25 feet west toward Webster Lake. Water leaves the pipe and flows as overland flow through the yard, down the slope, and into Webster Lake.

Grated inlet to Drain 29.

Outlet pipe from Drain 29.

Drain 30: The drain is located at EMS Lane W19 opposite Lane W19A. A road side drainage channel collects water from the east side of W19 directing it into a 12-inch corrugated metal pipe and underneath the road. The pipe which flows under the road is partially blocked with sediment and leaves. The receiving pipe is buried underground and runs down the hill approximately 200 feet to Webster Lake. The outlet of the pipe at the lake shore could not be accurately pinpointed; however, a pipe exiting the hill south of W19A may be the outlet pipe.

Inlet to Drain 30 east of W19.

Drain 31: The drain's inlet is located at 400 EMS Lane W19. A 12-inch square grate which is partially covered with leaves, sediment, and grass clippings is located to the north of driveway. Water flows south from the grate through a 10-inch corrugated metal pipe into a 12-inch round grated inlet. This inlet also receives water from a 12-inch corrugated metal pipe which runs from the southeast underneath W19. The pipe could not be located on the southeast side of W19. Water exits the southern grated opening through two 4-inch plastic pipes and flows approximately 400 feet west towards Webster Lake. Water exits the pipes and flows approximately 25 feet as overland flow before flowing over a concrete seawall/ramp into Webster Lake.

Northern grated inlet to Drain 31.

Southern grated inlet to Drain 31.

Drain 32: The drain is located opposite 212 EMS Lane W17. A drainage channel collects runoff from the east side of W17, directing the flow into an 8-inch corrugated metal pipe. The pipe runs west underneath W17 to a brick and concrete swale which runs 300-400 feet down the hill before reaching the lake. The pipe which runs underneath W17 is partially filled with sediment and leaves.

Pipe to Drain 32 which flows west underneath W17.

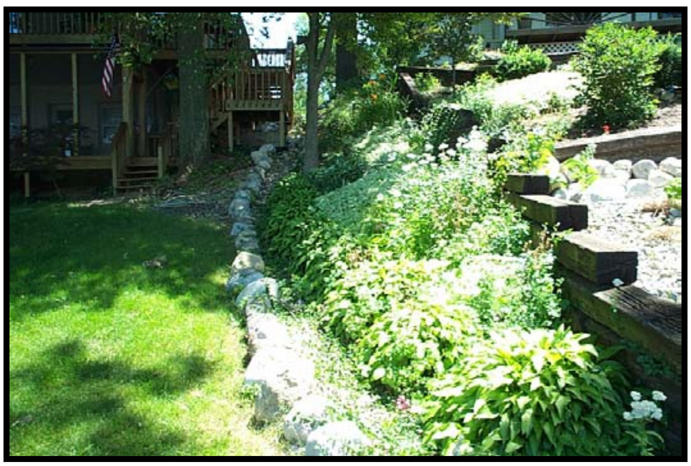
Brick and concrete swale constructed to direct water down the hill and into Webster Lake at Drain 32.

Drain 33: The drain is located along the southern side of the driveway at 94 EMS Lane W17 immediately south of W17A. A drainage channel collects water east of W17. The water passes from a 10-inch circular grated opening into a 10-inch corrugated metal pipe. The pipe passes underneath W17 and runs west to an open drainage channel. The channel is defined by two rows of boulders spaced approximately one foot apart; the channel is lined with pea gravel and runs approximately 400-feet west collecting gutter and yard runoff. A 6-inch plastic perforated pipe runs underneath the drainage channel along its entire length. The pipe outlets at a 12-inch by 18-inch rectangular grated inlet. The grated inlet showed signs of disrepair and was partially filled with leaves, sediment, and debris. Another 6-inch plastic pipe caries water from this inlet approximately 50 feet west to the pipe's outlet fifteen feet from the shore of Webster Lake.

Metal grated inlet collecting water from the west side of the road at Drain 33.

Surface drainage channel at Drain 33. A 6-inch plastic pipe runs underneath the length of the surface drain.


Surface and subsurface drainage channel to Drain 33.


Surface and subsurface drainage channel to Drain 33.


Grated inlet to Drain 33 near the lakeshore.

Drain 34: This drain runs along the north side of the driveway at 94 EMS Land W17. The drain's structure is similar to that of Drain 33. The channel is defined by two rows of boulders spaced approximately one foot apart; the channel is lined with pea gravel and runs approximately 250 feet west collecting gutter and yard runoff. It is believed that a 6-inch plastic perforated pipe runs underneath the drainage channel along its entire length. The channel ends just west of the house. From here the underground pipe carries water to a 12-inch square grated inlet. Another 6-8-inch plastic pipe caries water from this inlet approximately 100 feet west to the pipe's outlet in another 10-foot long section of boulder-lined, pea-gravel filled channel at the lakeshore.

Surface and subsurface drainage channels for Drain 34.

Grated inlet near the lakeshore for Drain 34.

Outlet of Drain 34 at the lake.

Drain 35: The drain is located at the top of the hill along EMS Lane W16A. A surface drainage channel lined with gravel collects runoff along the eastern side of the road. A 10-inch corrugated metal pipe passes underneath the road carrying water to a 14-inch round grated inlet approximately 50 feet west of W16A. The grate is partially clogged with sediment, leaves, and grass clippings; the structure below the grate is also partially clogged. Water exits the structure flowing south approximately 250 feet to a 1-foot square metal grate. A 4-6-inch plastic pipe also carries water into this structure from the south. The exact location of this pipe's origin could not be determined during the site inspection. Water exits the southern grate and travels west approximately 100 feet to a channel off of Webster Lake.

Northern grated inlet for Drain 35.

Southern grated inlet for Drain 35.

Drain 36: The drain is located at the east end of EMS Lane W16B. Water collects in a 14-inch round grated inlet adjacent to the house at the end of the road. A 12-inch clay tile carries water underneath the road approximately 400 feet to a channel connected to Webster Lake.

Inlet to Drain 36.

Outlet to Drain 36.

Drain 37: The drain is located at the north side of 27 EMS Lane W16B. Water collects in a 14-inch round grated inlet adjacent to the house. At the time of the survey, the inlet grate was partially clogged with leaves, grass clippings, and sediment. A 12-inch clay tile carries water south approximately 150 feet to a channel connected to Webster Lake.

Inlet to Drain 37.

Outlet of Drain 37.

Drain 38: This drain is located at the bend in the road adjacent to the driveway for 91 EMS Lane W15. Water collects in a surface drainage ditch running from the southeast to the northwest. The surface drainage and overland flow from W15 empties into a 15-foot by 2-foot rectangular metal grate. A second 15-foot by 2-foot grate continues northwest from and roughly perpendicular to the surface drainage and crosses the driveway at 91 EMS Lane W15. Water from both the southeast and northwest travels through a dirt and gravel filled trench underneath the second grate and into a gravel filled hole. A third trench covered by a grated inlet collects water along the south side of W15; this grate is approximately 25-feet long and 2-feet wide. Water from this trench collects underneath the grate and flows through a dirt and gravel trench into the gravel filled hole. Another 6-inch plastic pipe carries water into the drain from the east; the exact location of this pipe's origin could not be located at the time of the survey. Water from these four sources exits the drain through a 10-inch plastic pipe which flows 150 feet west toward Webster Lake. The pipe ends approximately 50 feet east of the lake; from this point, water flows through an area of bare ground, across a sparsely grassed area, over a concrete seawall, and into Webster Lake. A second pipe exits the seawall approximately 15 feet north of where overland flow carries water into the lake. This pipe may have originally been connected to the drain network; this could not be determined at the time of the field survey.

Drain structure at Drain 38.

Pipes entering and exiting Drain 38.


Outlet pipe from Drain 38; water flows from here approximately 50 feet to Webster Lake.

Drain 39: The drain's inlet is located at the top of the hill on the north edge of the cement driveway leading to 41 EMS Lane 14B. (B might not be correct; check this address.) Water from the road and adjacent yards pools in the cement depression located at the north edge of the driveway. A 6-inch clay pipe carries water from the depression west towards Webster Lake. A series of two parallel 6- and 10-inch clay pipes and a 12-inch plastic pipe carry water 400 feet to the lake. The exact pipe that carries water to the lake could not be determined at the time of the survey. Evidence of overland flow and erosion of the hillside was present at the time of the survey. It is believed that a portion of the original clay pipe has been replaced by the plastic pipe at some point along the route to the lake. Water flows from a 6-inch plastic pipe through a concrete seawall and into the lake.

Entrance pipe for Drain 39 in concrete depression.

Series of pipes at Drain 39 which convey water down hill toward Webster Lake.

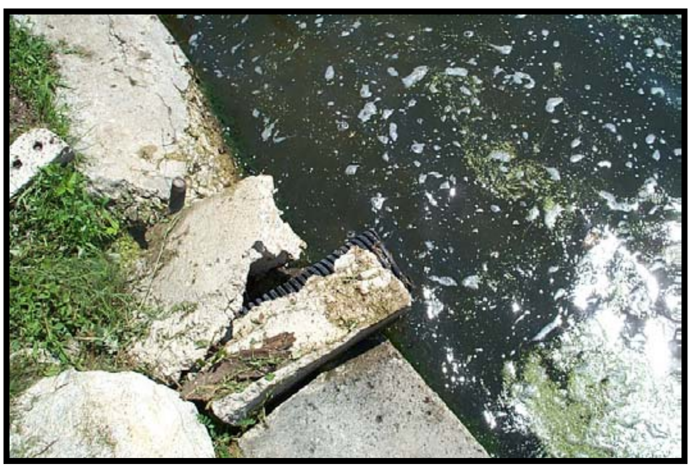
Outlet at Webster Lake for Drain 39.

Drain 40: Drain 40 is located adjacent to the west parking lot of the Echo Bay Condominiums along the north shore of Webster Lake. Water from the condominium parking lot is directed from the west edge of the parking lot into a stone-lined infiltration trench. Water drains from the trench into a 10-inch plastic pipe which runs east towards the building. The pipe drains into a 12-inch circular grated inlet lined with gravel. It is believed that the pipe continues southwest towards the lake; however, an outlet pipe along the lakeshore was not found at the time of the survey. It is likely that the pipe ends somewhere between its origin near the parking lot and the lawn leading to the lakeshore.

Plastic pipe and grated inlet at Drain 40.

Drain 41: The inlet to Drain 41 is located in the driveway immediately west of the house at 6527 Wade Lane. A 6-inch square grated inlet drains water to a 4-inch plastic pipe. The grate was completely covered by sediment at the time of the survey. The pipe runs south approximately 50 feet through a concrete seawall and outlets at Webster Lake.

Inlet to Drain 41.



Outlet from Drain 41.

Drain 42: This drain is located opposite 8501 Wesley Lane at the northeast corner of 9th Trail and Wesley Lane. The drain's inlet cover is a 14-inch circular grate located in a yard adjacent to the road. A 12-inch plastic pipe enters the drain from the north draining water from 9th Trail. The origin of this pipe was not located at the time of the survey. The structure of the drain consists of a 14-inch corrugated metal pipe placed perpendicular to the ground's surface, which appears to be free of debris. Water exits the drain through a 12 inch plastic pipe which travels south underneath Wade Lane approximately 300 feet to Webster Lake.

Grated inlet to Drain 42.

Drain 42 outlet pipe located underneath the dock.

Drain 43: Drain 43 originates as a driveway drain measuring approximately 12 inches in width and running the width of the driveway (approximately 8 feet). Water drains out of the bottom of the grated collection area through three 2-4-inch diameter pipes. A larger 4-6-inch plastic pipe collects drainage from the three pipes and runs southwest to a second inlet. A 14-inch square plastic grated inlet collects water from the house, gutters, and driveway in addition to receiving water from the neighboring driveway drain. Water exits the west drain inlet through a 6-inch plastic pipe and runs south approximately 200 feet to a concrete swale. The concrete swale directs water downhill approximately 25 feet to the lake.

East inlet to Drain 43.

West inlet to Drain 43.

Outlet to Drain 43.

Drain 44: Drain 44 starts as an asphalt-lined swale at the south side of Wade Lane. A 10-inch square inlet collects water from the yard, parking area, and gutter. Water exits the inlet through an 8-inch plastic pipe to the swale. The swale runs approximately 100 feet south between two houses to a 10-inch square brick-lined drain inlet. This inlet receives water from another 8-inch plastic pipe flowing in from the northeast. The origin of this pipe was not located during the site survey. A 12-inch plastic pipe directs water from the brick-lined drain, down the hill, and outlets in a concrete swale approximately 15 feet north of Webster Lake. Water flows from the pipe, through the swale, over the seawall, and into the lake.

Grated inlet for Drain 44.

Grated water collection point for north and northeast drainage to Drain 44.

Concrete swale and plastic pipe directing water from Drain 44 to Webster Lake.

Drain 45: Drain 45 consists of a concrete swale which runs south from Wade Lane. A concrete swale draining areas around a house to the west and a pipe draining water from a house to the east connects with the concrete swale. The concrete swale directs water approximately 200 feet from the side of Wade Lane, between the two houses, down the hill, across a concrete seawall, and into the lake. The property owner has installed a board across the seawall at the lakeshore to prevent water from pooling on the top of the seawall's surface during storm events.

Concrete swale of Drain 45 from house and drain pipe from gutters.

Concrete swale leading from Wade Lane to Webster Lake.


Drainage path of Drain 45 over a seawall on the north shore of Webster Lake.

Drain 46: Drain 46 originates as two parallel grated driveway drains immediately south of Wade Lane. The drains measure approximately 3 inches in width and span the entire width of the driveway. Water from the two drains collects in a 4-inch plastic pipe which runs underground around the house, down the hill, and into Webster Lake.

Grated inlets to Drain 46.

Drain 47: Water from a driveway immediately south of Wade Lane collects in a low spot in the concrete before emptying into a 4-inch plastic pipe. The landowner placed wire in the drainage pipe opening to limit the amount of sediment and debris entering the pipe. The pipe runs underground approximately 400 feet south to exit through a concrete seawall at the lakeshore.

Inlet to Drain 47.

Drain 48: This drain system collects water along the length of 5^{th} Trail. The northern grated inlet is located on the east side of the road at 6652 5^{th} Trail. The grate is a 12-inch circular cement slab with two visible drain holes. The grate is covered almost entirely covered with grass clippings and dirt. It could not be determined whether additional pipes carry water into this drain. Additional inlets north of this one along 5^{th} Trail could not be found at the time of the survey. It is believed that water exits the drain to the southwest traveling through a 10-inch plastic pipe underneath 5^{th} Trail to a second grated inlet. The southern inlet is located on the west side of 5^{th} Trail immediately south of the driving leading to 6641 5^{th} Trail. This inlet is covered by an 18-inch grate. In addition to the 10-inch pipe from the northern inlet, a 4-6-inch plastic pipe carries water into the drain from the west. The origin of this pipe was not located during the survey. A 10-inch plastic pipe exits the drain in a south-southwesterly direction. It is believed that the pipe carries water from the southern inlet approximately 600 feet to Webster Lake. Additional inlet openings could not be located between the southern drain at 6641 and the outlet pipe indicated by the landowner at the lake. The 10-inch plastic pipe outlets on the west side of Frost's pier at 8123 Wade Lane. Mr. Frost indicated that the outlet pipe carries water from the entire length of 5^{th} Trail.

Northern grated inlet to Drain 48.

Southern grated inlet to Drain 48.

Outlet of Drain 48.

Drain 49: The drain is located along Wade Lane immediately west of 5th Trail. The drain's inlet is covered by a 14-inch circular grate. No pipes carrying water into the drain were identified at the time of the survey. A 10-inch corrugated metal pipe carries water south underneath Wade Lane to a second drain. The drain is located immediately west of the driveway for 8123 Wade Lane. This inlet is a 10-inch circular grate. Mr. Frost indicated that water travels through a plastic 8 inch pipe located west of the sidewalk adjacent to his house before flowing downhill approximately 300 feet to Webster Lake. Water exits the drain through the same 8-inch plastic pipe located in the seawall east of Mr. Frost's pier.

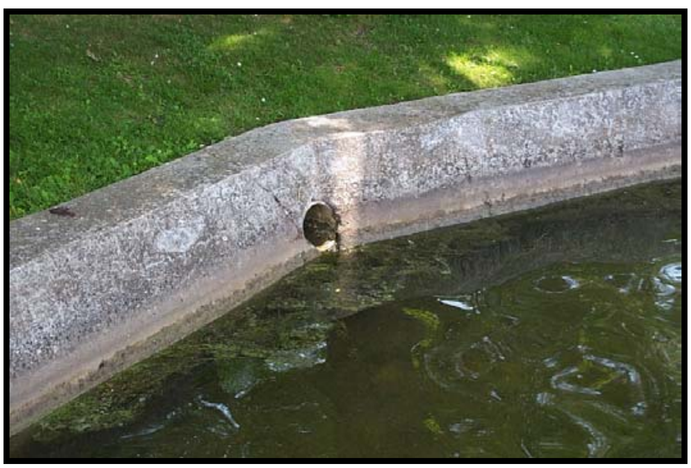
Northern inlet to Drain 49.

Southern inlet to Drain 49.

Outlet to Drain 49.

Drain 50: The drain is located at the southeast corner of the intersection of Wade Lane and 2nd Trail. The drain's inlet is covered by an 18-inch square grate. A 10-inch clay tile carries water from the north into the drain. The tile is broken as evidenced by the blow out to the north of the drain. The origin of this pipe was not determined during the survey. Additional drain inlets north or east of this drain could not be found either; therefore, it could not be determined at the time of the survey whether additional pipes carry water into the drain. Water exits the drain through a 10-12-inch clay tile which travels west approximately 150 feet to Webster Lake. The pipe travels through a concrete seawall before reaching the lake.

Grated inlet to Drain 50. Note the broken tile as evidenced by the blow hole located to the north drain.



Outlet to Drain 50.

Drain 51: The drain is located at the southeast corner of the intersection of 1st and 3rd Trails. The drain's inlet is covered by an 18 inch grated metal grate. Water collects in the concrete drop structure located beneath the drain. The drop structure was partially filled with sediment and debris at the time of the survey. Leaves, grass clippings, and debris were collecting in the area around the grate at the time of the survey. Water exits the structure through a 10-inch clay pipe which travels southwest underneath 1st Trail to a second inlet. The second inlet is covered by an 18-inch square metal grate. The inlet's concrete drop structure was partially filled with sediment and debris at the time of the survey. A 10-inch clay pipe carries water from the structure southwest approximately 200 feet to Webster Lake. Water flows from the pipe through a concrete seawall and into the lake.

Northeast inlet to Drain 51.

Southwest inlet to Drain 51.


Outlet to Drain 51.